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## THE LAMME AWARD

**To Andrey Abraham Potter—for his leadership in the advancement of the profession of Engineering; for his devotion to high standards of teaching and his contributions to the development of engineering education; for his understanding of human nature and sympathetic interest in the work of his associates and students; for his sound judgment and his skill as an engineer; and for his untiring efforts in developing coöperative relations between engineering colleges and industry the thirteenth Lamme Medal for Achievement in Engineering Education is awarded.**

ANDREY ABRAHAM POTTER, the thirteenth Lamme Medalist of the Society for the Promotion of Engineering Education, was born in Europe, August 5, 1882, and came to the United States at the age of fifteen. In 1903 he was graduated from Massachusetts Institute of Technology with the Bachelor of Science degree; in 1925 he was awarded the honorary degree of Doctor of Engineering by Kansas State College; and in 1936 he received the honorary degree of Doctor of Science from Northeastern University.

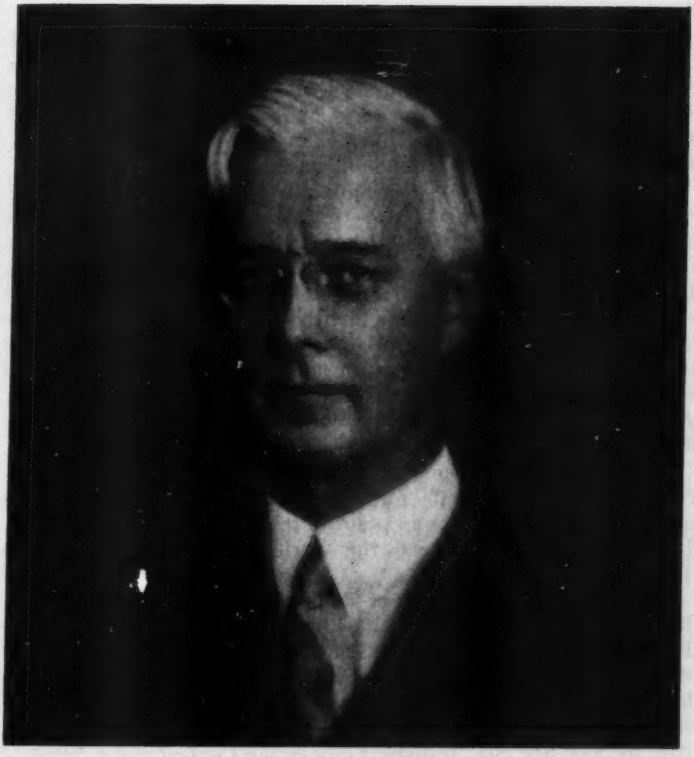
From 1903 to 1905 Dr. Potter was employed by the General Electric Company at Schenectady, New York. He joined the teaching staff of Kansas State College in 1905 as Assistant Professor of Mechanical Engineering, and in 1913 became Dean of Engineering and Director of the Engineering Experiment Station. Since 1920 he has been at Purdue University as Dean of the Schools of Engineering and Director of the Engineering Experiment Station and of Engineering Extension Service. Dr. Potter has served as a consulting power engineer for over twenty-seven years.

Dr. Potter is author of a number of books on power engineering, thermodynamics and farm motors and of more than three hundred engineering, educational and scientific papers and articles. He has served as Advisory Editor for Ginn and Company; on the Editorial Advisory Board of *Industrial Power;* on the Editorial and Educational Advisory Board of *National Engineer;* and as Chairman of the Advisory Committee for "Who's Who in Engineering."

In the service of the United States Government, Dr. Potter has served as Associate Member, U. S. Naval Consulting Board, 1917–19; Director, Industrial Preparedness for the State of Kansas, 1917–18; District Educational Director, War Department Committee on Education and Special Training, 1918–19; Consulting Expert, U. S. Bureau of Education, 1928 and 1931; Consultant, National Resources Committee, 1936 and 1938.

During Dr. Potter's professional career he has been associated with the following organizations: Fellow, A. S. M. E. (President 1932–33); Fellow, A. A. A. S. (Vice President 1938–39); S. P. E. E. (President 1924–25); E. C. P. D. (Chairman, Committee on Engineering Schools 1939– ); Research Advisory Board to the Association of American Railroads; Advisory Board to Coördinator of Transportation; Construction Committee, U. S. Chamber of Commerce; N. E. L. A. (Prime Movers Committee 1920–33, Public Relations Section 1925–27); Honorary Member, American Association of University Professors; Honorary Member, National Association of Power Engineers; Kansas Engineering Society (President 1919–20); Indiana Engineering Society (President 1922–23); Association of Land-Grant Colleges and Universities (Vice President and Acting President 1921–22, Chairman Engineering Section 1926–27, Secretary Engineering Section 1914–19); Trustee, Engineering Foundation; A. E. C. (President 1936–38, Chairman Patent Committee 1939– ); Sigma Tau, Tau Beta Pi, Phi Kappa Phi, Sigma Xi, Scabbard and Blade.

Dr. Potter married Eva Burtner of Manhattan, Kansas, in June, 1906. There are two children, James Gregor and Helen.



DONALD BISHOP PRENTICE

Donald Bishop Prentice was born at Hartford, Conn., on April 27, 1889. His father, Charles Hills Prentice, was a junior officer of the Hartford Machine Screw Co. of which Christopher Minor Spencer, inventor of the automatic screw machine, was engineer. These two men withdrew from the Hartford company in the early nineties and organized the Spencer Automatic Screw Machine Co. of Windsor, Conn. The partnership was shortlived, however, as Mr. Prentice died in 1895.

President Prentice prepared for Yale College at the Hartford High School. A decision to change to the Sheffield Scientific School

required an extra year of preparation in physics and mathematics to replace the credits in Greek and Latin and this year was spent at the Hotchkiss School. Mr. Prentice was graduated from the mechanical engineering course at Yale with general honors in 1910.

Two years following graduation were spent in the employ of the Britton Company of Hartford, the latter part of the period as shop foreman. From 1912 to 1914 Mr. Prentice was a graduate student in mechanical engineering under L. P. Breckenridge at Yale and received the degree of M.E. in 1914. From 1914 to 1917 he was an instructor in the same department.

In 1917 Mr. Prentice was appointed head of the mechanical engineering department at Lafayette College which position he held until 1931. From 1924 to 1931 he was dean of the college and he served as acting president for the academic year 1926–27. Since 1931 he has been president of Rose Polytechnic Institute.

While an instructor at Yale Mr. Prentice registered as a graduate student in the department of education. These credits were transferred to Lafayette and with additional courses and a thesis satisfied the requirements for the M.A. degree. The honorary degree of LL.D. was conferred by Wabash College in 1932 and the degree of Sc.D. by Lafayette in 1936.

From April to November, 1918, Mr. Prentice was civilian director of Camp Lafayette for the vocational training of drafted men, and he served also as assistant to the regional fuel conservator. In 1929 he was a delegate to the World Engineering Congress in Tokyo.

Mr. Prentice is a member of Tau Beta Pi, Sigma Xi, Blue Key, Book and Bond and Kappa Delta Rho. He prepared "Problems in Industrial Organization" (McGraw-Hill) for use with Kimball's "Principles of Industrial Organization" and for the past five years has written the section on mechanical engineering in "The American Year Book." He is a member of A. S. M. E., A. A. U. P., Am. Ac. Pol. Soc. Sci., Indiana Engineering Council and a fellow of the A. A. A. S. For the committee on colleges, E. C. P. D., Mr. Prentice has been a member and, for a time, chairman of the Region III delegatory committee.

In 1912 Mr. Prentice married Mary Louise Farnham of South Windsor, Conn. Their three daughters, Katherine Farnham, Mary Osborne, and Barbara Bishop, are Wellesley, '36, '37, and '41, respectively.

# PREPAREDNESS AND THE ENGINEERING COLLEGES

By DONALD B. PRENTICE

President, 1940–41

When President Ferguson chose the "Unfolding Obligations of Engineering Education" as the general theme for the very successful 1940 convention he could hardly have had in mind what unexpected obligations might unfold in the months following the Berkeley meeting in connection with national preparedness. That there will be specific obligations placed upon the engineering schools is certain; just what they will be is not definitely clear at the moment (August 12).

At Berkeley President Ferguson reported in detail the steps which had already been taken by various government officers and advisory committees, even relaying to the convention within a few hours information received from Washington by telephone. (Not, however, in the manner of a later convention.) Since then your president and secretary have attended two meetings in Washington of representatives of national educational associations at which preparedness measures were discussed and full support of the government departments was pledged. No tangible results could have been expected from these meetings, probably, because Congress had not then acted on the compulsory military training bill nor that which calls reserve officers to active service. The engineering schools may be seriously affected by the latter and to some extent by the former.

Dean A. A. Potter has spent a major part of the summer in the office of Dr. Studebaker, Commissioner of Education, as adviser on engineering training. Dean Potter has not only collaborated on the formulation of plans to be presented to Congress but has expressed to innumerable persons in authority in Washington the hope of engineering educators both to be of assistance to the government in the emergency and to maintain for industry the needed supply of technical graduates. Your officers have been in frequent touch with Dean Potter by mail and telephone.

Industrial demand for technically trained men is strong and will increase, for preparation for defense is largely technical activity. Engineering college administrators, especially those who deal with prospective students and their parents, should constantly emphasize this immediate and growing demand for graduates. Regardless of the extent to which the selective draft may temporarily reduce engineering enrollment (if deferred training is not permitted) increased registration of new students must provide the men required by industry. If necessary, engineering colleges must introduce summer terms to shorten the undergraduate training period to three years. This plan, of course, has the double advantage of meeting industrial needs at an earlier date and of completing the undergraduate courses for a larger proportion of students before they reach the draft age.

The officers of your society have been and will continue to be at the service of the government and will immediately transmit to the members any significant information in regard to participation in emergency training.

# IS THE PHILOSOPHY OF ENGINEERING EDUCATION CHANGING?*

PRESIDENTIAL ADDRESS BY OLIN JEROME FERGUSON,
President of the Society

Engineering education in America stemmed out of the vigorous spirit of a pioneering race bent upon using Nature's riches more effectively. Described in the simple words of thoughtful men, the concept called for "the applications of science to the common purposes of life." A somewhat more elemental expression of purpose proposed "to give the farmers and mechanics such scientific knowledge as would enable them to become skillful in their professions."

We are impressed by the breadth and the perspective of these phrases both as a basis for development and as an indication of the attributes of the men who framed them. The universality of their coverage was an expression of the democracy of our people. Only that application useful to the whole of industry would be acceptable. The perspective of the plan, though no doubt undiscovered at once, gives testimony to the depth of character of the searchers. Only that design which opened the future could satisfy the spirit of the pioneers.

The actual beginnings of engineering education in this country were just as simple and as direct as were the thoughts of those early planners. This followed, of necessity, because the science of a century and a half ago was a meager affair. It was the plaything of the learned, a source of amusement to the savant and amazement to the untutored. Acquaintance with it (there did not exist an understanding of it) bestowed upon its demonstrator either fame and high rank as a powerful mystic, or the doubtful distinction of being a shady conjurer. The days of black magic were passing, but they still tinged lay thinking. Mechanics and technicians were beginning to find the utility of certain physical phenomena, and to develop experimentally machines to use them. Yet, the gap between science and industry was a Grand Canyon.

As pointed out by Wickenden in his report upon European education, these same conditions existed abroad for various reasons. Science was scholastic. Industry was experimental and manual.

* Presented at the 48th Annual Meeting, S. P. E. E., University of California, June 24–28, 1940.

To inject into this situation the idea of the industrial application of science was revolutionary, and the suggestion was resented as degrading. To propose that education should undertake to do the job was little short of sacrilege. Educational institutions had been established along the old classical lines, and not one of them would consider for a moment this surrender of lofty thought to lowly application. The union of science and industry would have to be consummated without benefit of clergy.

Time passed and the initial efforts were made to erect schools of applied science in this country. The very earliest schools were unable to establish themselves firmly, and went down of neglect. There were not enough takers and not enough supporters. Even believers were few, but the simple industry of the time seemed to provide the needed urge for continued effort. Agriculture, transportation, manufacture, processing of raw materials—all these must be accomplished and accelerated. Our nation needed the cohesive force of common industry and facile intercourse of trade to effect the confederation of its scattered centers of population into a commonwealth. The developing of agricultural resources, the establishing of more industries, and ready transportation, therefore, gave force to the demand for putting science to work. And this established the simple philosophy of early engineering education in America. Science must be a producer.

As we know, schools of agriculture and mechanic arts succeeded in gaining recognition largely through government prompting and assistance. The Morrill Act brought them into being for the specific objective of promoting "the liberal and practical education of the industrial classes in the several pursuits and professions of life." More extended technical practice was the expressed concern of this act. With advancing industrial development, and increasing activity of invention, the safety range between technical practicality and financial success narrowed. Whereas in the early stages of production emphasis was laid upon practicality, it became increasingly necessary to count the cost. Highways and bridges, railroads, communication systems, power generation and distribution, manufactures, steel structures, buildings,—all advanced in such volume and under such competitive stress that a demand ensued for cost reduction and the thrifty use of budgets. Engineering economy became potent. The schools quickly recognized the soundness of this usage, and taught that, to be successful, an engineering project must be not only technically practicable but it also must be economically sound. We added to our curricula courses in cost accounting, scientific management, and economics, but even more to the point, we applied economic principles in our own engineering teaching, and thus interpreted and objectified

them. And this was done to give us a more stable and secure footing in the economy of industry.

Our educational philosophy advanced a step. We assumed the duty of inculcating the idea of economic justification of our works.

But it must be pointed out that the introduction of the economic aspect in no whit lessened the importance of the requirement of practicality. We simply recognized another phase of engineering responsibility, and accepted it as a refinement in our practice.

Engineering education in the United States has never been static. It has always been submitted to question and to criticism. Fortunately, the most vigorous critics have been those who are engaged in engineering education,—those who have known the most about it. It is true that others have given us thoughtful observations which have been constructive and helpful. We have profited at the hands of our friends and also our disparagers. But most have we gained by examination and criticism self-imposed. As the greatness and strength of democracy are attested by democracy's ability to benefit from self-censure, so the virility of engineering education is evidenced by its improvement under self-correction. That frank display of imperfections which the casual observer often takes to be a sign of weakness is, in fact, a prime mark of vigor.

And so today, as in our extended studies of fifteen years ago, engineering education is undergoing a scrutiny as intensive as our optical instruments make possible. Perhaps I may say we are using the new electronic microscope, and attaining magnifications never before achieved. Witness any of a hundred quotations we can select bearing upon the problems and responsibilities of education.

I choose one from Luther Halsey Gulick, believing that it expresses our convictions, even in the face of open challenges to it these days by certain World states, which seem to make it strange reading.

"In the past generation one era of world history closed; a new one is now opening. Apparently this new era will belong to those who can learn to work together intelligently, happily, and productively with the aid of modern science without exploiting natural resources, foreign peoples, or submerged classes. This would seem to require coöperative skill, a high degree of universal education, much scientific research, great capacity for self-government, and the ability to meet changes in the natural and social world without panic. If this conclusion is sound, one key to the future lies in education."

From the Educational Policies Commission, I take several quotations, and I italicize words which I believe to be especially important to us in these present considerations.

"Education in the past has contributed in providing specific vocational skills as well as general economic understanding essential to the existence and highest productivity of an economy characterized by far-flung organization, specialization, and power-driven machines. In the future it can and should make greater contributions to productivity in these areas. *Workers with trade skills and economic intelligence are consistent both with democratic culture and maximum productivity.*"

Again, "*Occupational mobility* of labor is of increasing importance in a dynamic economy in which new discoveries are continually creating new vocations, many of which involve technical training. Education in the past has assisted in thinning out the overcrowded ranks of unskilled labor by increasing the proportion of workers in skilled and professional occupations. Its contribution in this area in the future should and can be made far more effective."

Another: "Higher education today presents examples of programs which fall short of maximum contribution to both general and occupational education. In some instances, this is due to *a curriculum too far separated from real life.* This condition reflects the pedantic assumption that liberal education must be divorced as far as possible from the workaday world and the practical affairs of mankind. In other instances, it is due to *too much emphasis in the preparation of professional workers on the minutiae of their calling, while the social and economic orientation to intelligent service in a profession is largely neglected.*"

A challenge to our earlier practices appears in the next: "One of the most serious threats to the maintenance of a democratic, industrial civilization is the social illiteracy often exhibited by professional workers. *Higher education makes a similar mistake when it assumes that the general education of young men and young women of twenty and even of twenty-one and twenty-two years of age is best accomplished without taking some account of the economic problems of society and of the vocations which most of them will be entering shortly.* The value of higher education, as it affects general culture, economic, and occupational well-being can be substantially increased."

May I take a few words from an address by Mr. Ralph Flanders, upon the theme of "The Engineer in a Changing World" (*Elec. Eng.*, 1937).

"As to our responsibilities, they are great. Perhaps the greatest of them lies in the understanding of the nature of the mechanisms and of the organizations on which depend the material interests of our generation. It is hard to say *whether the greatest danger to them lies in their being perverted and frustrated by*

*powerful selfish interests, or in being overthrown by the recklessness and ignorance of our fellow citizens—even by those moved by the best of intentions.* Our material blessings do not come naturally, as fruit grows on a tree. They come because thousands of individuals, having engineering and organizing skill, devote themselves in large and small capacities to keeping the machinery of civilization in running order. *It is an inescapable duty, that we each make of ourselves centers of education and influence, to the end that our useful offices may continue, and our civilization fulfill its destiny of an ever-growing service to the needs of mankind."*

When we examine the most severe criticisms of engineering education today, we find that they revolve about our attitude toward the social implications of technology. We are not developing the ability of accurate analysis of the effects of technology's impact upon society. We are not acquiring a sufficient acquaintance with social processes, relations and reactions upon which to base such study. We are not assuming the obligation of the consequences of our works. We are not gaining a clear concept of technology's moral obligation in the modern world. Nor are we preparing our students to do much better than we have done. Yet, clearly, it is the responsibility of a profession to prepare itself to serve society adequately, in its field.

The engineering profession is prepared to go further technically today than engineering economy would dictate. It is not well prepared to do justice to society in the ethical application of its arts. And society itself lacks the wit safely to avail itself of its danger-laden opportunities. As men are crowded closer and closer together by an increasing population and a shrinking world, patterns of rights and responsibilities change.

Dean Pound, in describing the development of law refers to successive stages in terms of common law, scientific or codified law, and sociological jurisprudence. Engineering is arriving at a point analogous to this last-named region of operation, and it must concern itself with analogous problems. Unless the engineer can successfully thread the intricacies of these paths, he will not emerge from the disordered crowd of empirics. Only straight thinking and straight walking will see him through.

A dangerous attribute which is too typical of the American mind is the tendency to overemphasize the obsolescence of ideas. A newly recognized element in the solution of a knotty problem is presumed to replace the proved bases upon which we have been working, and we discard our old system of action, to try the new one. This always leads to disaster, because no such sudden change of foundation ever is warranted. Safe procedure demands de-

liberate and slow changes, with time for study of effects and for making of readjustments.

This observation applies with full force to the emphasis of the social factor in the operation of engineering enterprise. And while engineering has as its only ultimate objective social advancement, many of the collisions of today's social legislation with industry have been mutually disastrous, because this safety measure has not been observed. The several elements of engineering practice must be analytically determined as separate entities—technical practicality, economic soundness, social well-being. Each has its important worth, and each must be singularly apprehended before the project may be synthesized. Only by this method of procedure shall we know what we are doing and why we are doing it—how much weight we attach to each element. Only by this process can we assure ourselves that we are still giving proper heed to practicality—that prerequisite to claim to any further notice.

One of the great elements of this year's work of our Society is the attention that has been given to a study of the aims of our curricula and their scope. To know our objectives is the first consideration of progress. To recognize our present status and our attributes is a necessary preliminary to any start along the way. With the presentation of a committee report in our JOURNAL of last March, and its discussion at this convention, much is done to clarify our thinking. As we give the sessions of the society thoughtful attention and study, we must approach the unfolding obligations of engineering education in the spirit of research and unshaken faith in continued advancement.

I submit that the philosophy of engineering education has advanced to this thesis: Engineering education is obligated to provide a sufficient proficiency in the art and science of engineering to enable the engineer to discharge his professional duties; it must afford him a degree of competence beyond that of other men to apply his knowledge with sound economic result; it must impel him to achieve a general literacy that fits him to understand the salient issues involved in social living in an age of technological advance; and, to a continually increasing degree, it must inspire him to resolve these issues.

I believe that steady progress will continue to be made. Engineers have had to do the work of applying economic principles in their field because they alone were familiar enough with practice successfully to apply even fundamental economic theory. It is probable that the social adjustments necessitated by the engineers' productiveness will likewise fall to their lot in large part, when they are prepared to assume them, and for the same practical reason. This will not be accomplished by mere teaching of courses

in the humanities by the several departments representing these subjects. It will require, as did economics, the actual interpretation of the underlying principles in engineering class-rooms and laboratories, by men of discretion and wisdom; by men who can invest concepts with substance; by men who can incarnate ideas.

Engineering practicability, engineering economy, and the adaptation of technology to social good, thus, devolve upon the engineer. But the perils of living mount daily. We are heart-sick that the arts of science are being debased to destructive ends. We are humiliated that industry's gifts are dishonored in use. The time now is when, in this regard, that too masterful servant of society, politics, is in distressing need of moral instruction; when to our obligation to provide for social good there must be added a measure of responsibility for administrative equity and political justice.

And the philosophy of engineering education advances to new levels.

## ADDRESS

By MONROE E. DEUTSCH

Vice-president and Provost, University of California

To you who are gathered to devote yourselves to the problems of training engineers in the great variety of fields which fall under the name of engineering, I give a most cordial welcome in behalf of the entire University of California. In the words of those who once inhabited this state, "The house is yours."

We shall profit greatly by your presence among us, and we trust that those among you who for the first time tread the soil of California will find us like the rest of you, despite some of the impressions you may have received of us in the past.

In view of the high importance of engineering in our modern world, the task of training future engineers in the most successful manner stands in the very forefront of educational problems. We are glad that you have come to the edge of the continent for your meeting. But in these days problems of engineering education are far from being our only problems, as you well realize. Many things that we have taken for granted we now see in a clearer light, and many things which would have seemed fantastic have become possible, nay, even probable. And among the things of which at this time in the world's history it is especially essential that we take stock is our American citizenship and its significance. When about us in other lands we see destruction, suffering and death; when everything that in the world's slow progress we have come to treasure and prize is trampled in the dust; when law is the might of the strongest, while freedom and democracy are only words to be mocked, education is the tool of the dictator, and religion is derided; then amid such a world let us survey our peaceful land, wherein the dignity of each individual is still respected, the clergy of every creed may still call the faithful to worship God as their consciences dictate, and concentration camps and terrorism are, thank God, absent.

It is but right that we pause to give thought to our American heritage, and realize how richly we have fared through the hardships which were borne by those who dared to come to this land, those who courageously set up the infant republic, those who protected it throughout the years, and those who bravely pushed the frontiers westward till they reached this remote ocean.

We have a right to be proud that we are American citizens; but we have no right to take personal pride in what our nation stands for. That is the work of countless men and women, famous and unknown, whose very life blood has gone into the very foundations of this country. It is ours to maintain its principles by indefatigable attention to our duty as citizens, and to defense of the democratic ideal in this land.

It is, of course, obvious that general education is essential in a democracy. For how can we otherwise meet the responsibilities of our citizenship, great as they certainly are? But despite the fact that in dictatorships all such responsibilities are borne by a single individual and the people as a whole are free from them, we are, I know, absolutely agreed that we prefer these responsibilities, heavy as they may be, to be ours rather than to see them placed in the hands of one man, subject to his caprice and decided in accordance with his personal views and his personal ambitions.

And democracy has the stronger foundation in proportion as education is disseminated throughout the land. After all we cannot properly choose our officials and our legislators unless we study carefully and intelligently both their records and their platforms. And what are the latter but statements of their methods of meeting governmental problems? General education is assuredly essential in a democracy. But in addition education opens the doors of opportunity to every young man and woman who has ability and is willing to put forth the necessary efforts. Here we have education freely available from the kindergarten through the graduate school of our universities. This it is that keeps us from congealing into fixed strata and makes real the promise of American democracy. And all institutions constantly seek out youths of ability, and through scholarships open educational facilities to them.

Our land is still the land of opportunity, and each of us must be grateful that that magic key, education, is here ready to be placed in the hand of anyone who really has the desire and the will. It is not a privilege reserved to a class or to wealth. The boy or girl in school or college can engage in any type of work for self-support without losing a single iota of respect; nay, he gains mightily in our respect. We are proud of the achievement of those who against the greatest of handicaps have made their way. And that this is possible is the glory of education in a democracy.

Furthermore, it must be remembered that education is not really education when it is muzzled and confined. This freedom, of course, does not exist for the sake of the teacher, but because we know that it is only by removing such shackles that men and women can learn to use their minds and be trained to govern themselves.

Only thus too can knowledge be pushed into realms previously untrodden.

But this, of course, it must never be forgotten, imposes obligations in turn upon the teacher. Academic freedom is intended to protect him as a scholar; whenever he passes outside of the field of his scholarship, academic freedom should not be used as a shield to protect him; then he has no greater freedom and no less than any other citizen.

There is an added obligation on the teacher in return for this precious gift of academic freedom. He must assume in all he says the scholar's attitude and shun the propagandist's. He knows how debatable most questions are and he should refrain from dogmatism. His should be the detachment and the impartiality of the true scholar. But if any group seeks to muzzle him in his teaching, woe betide the university, should it yield, for then the basis upon which universities rest is gone and scholars become mere lackies of popular clamor. What we have then is no longer a university; it is merely a loud speaker for what the crowd thinks.

American education is not—and must never be—dictated or shaped to foster a particular way of thinking; such education treats the mind of the young as the Chinese once treated women's feet—binding and distorting what should be unconfined. Neither such feet nor such minds are capable to stand alone then.

We must be not merely American citizens but devoted citizens. Above all should we seek the good of the people as a whole, not of one state, or of one locality, nor of one occupation, nor of one class. Our government exists, as the constitution expressedly states, "to promote the general welfare," and those who selfishly seek their own advantage at whatever the cost to society as a whole are not good citizens.

We who were born on this soil have a responsibility to safeguard that for which our parents or our ancestors braved hardships to come across the ocean to this then remote land. Every risk and every privation which they faced impose on us an obligation to protect that for whose sake they came.

But it rests no less on those who of their own volition came from other lands in more recent days. Each took a solemn oath to this, his new country, and forswore allegiance to the government of the nation which he had left. Many came to escape the horrors of cruel, tyrannical regimes. To them this land has been a haven of refuge. Here freedom has been found. Sometimes I wonder whether those who become American citizens of their own desire rather than by the accident of birth may not see more clearly how blessed we are than we who have always lived in this land of liberty.

And we must never forget we have no right to boast of our devotion to democracy and yet at the same time deny opportunity to our fellow-Americans on the basis of race, religion, color, or ancestry. Every American citizen must be treated as such; no barriers must be erected in respect to that citizenship, if we are really honest in our espousal of democracy. Accordingly, when candidates for public office present themselves, we must, if our democracy is not a spurious democracy, indignantly repel anyone who may seek to sow the seeds of discrimination of any kind whatsoever. Men must be judged for what they themselves are never on the basis of their wealth, their ancestry, their trade, their profession or their religion.

It is ours to perpetuate that which has been handed down to us, the treasure which is entrusted to us as temporary guardians—temporary, I say, for we have the great responsibility of seeing that it is passed on intact to the many generations that will follow us. Do you wish your children and your children's children to live with heads erect, the citizens of a democracy, or become the puppets of a totalitarian state? Do you desire to keep the American road open to them, or will you say, "I care not for the future of the grandchildren whose arms now cling about my neck"? You cannot say that. The American dream has always meant opening the door of opportunity for future generations. Those who faced the trials of the wilderness and the frontier did so to give their children and their children's children the chance which had been denied them.

If refugees from abroad greet the first sight of the statue of Liberty with joy in their eyes, have we not equal reason to feel the deepest of gratitude to our country? We must let our minds dwell on the mere accident, the mere chance which made us citizens of these United States, sharers in the blessings of freedom instead of the dreadful sufferings being endured today in the lands which were the homes of our parents and our ancestors. We should have hearts full of gratitude for all that we have and all we have escaped. And our only method of repayment is by fulfillment—to the full and running over—of our duties as American citizens.

There is no greater virtue than loyalty. It is the great virtue. In very truth it is the mortar that binds society together. And assuredly loyalty to our nation is a primary virtue. Above all do we have a duty to that form of society which grants the individual so much in the way of freedom.

We recognize that the state, our state, is not perfect, that there are many opportunities to bring it nearer to our dreams. But this no more lessens our love and devotion to her than the fact that, though we see weaknesses and blemishes in the human beings close

to us, whether by blood or affection or warm friendship, it makes us no less loyal, devoted to them. Possibly we should not love them so much if they were wholly free from blemish, if they were perfect, faultless and no longer human. And so this state of ours, built by imperfect beings, reveals to us timbers to be strengthened, seams to be closed. And we should rejoice that we have not received something perfect and complete, but something to whose betterment we can make our contribution, that we can play our part, however small, in making it the thing of which we dream. So the call to each of us is to be loyal, to be devoted to this government of ours, to do our utmost to make it even better, and to protect and maintain it with all the strength of which we are capable.

In our land citizenship is shared alike by men and women, young and old, by those in whose veins flows the blood of every land on the face of the globe, by human beings, white, black and yellow, by Catholics, Protestants and Jews—but our differences are as naught compared with the great tie that binds us together, the blessing of American citizenship. Indeed the very differences and the fact that we are protected in those differences, and that despite them we are all citizens of this land, are the greatest glory of our American citizenship.

Let these tragic days in the world's history bring to us a deeper recognition of the greatness of that title—and a stronger determination to safeguard that democracy which bestows it upon us.

We of many bloods, of varied hues, of diverse creeds—but all equally Americans—join hands in fervent devotion to our land and its government. Blessed by freedom we solemnly pledge that we shall maintain it for ourselves and for those who shall come after us.

# AN ENGINEER'S VIEW OF ENGINEERING EDUCATION *

By D. B. STEINMAN, Consulting Engineer

When President Ferguson invited me to prepare this paper for the annual meeting of S. P. E. E., I at first declined but finally yielded to his continued and cogent persuasion. The invitation is accepted as an indication of a sincere desire on the part of educators to get an outside viewpoint on their problems. This paper is presented at some sacrifice and in all sincerity, motivated only by a sense of professional obligation.

Since every man's philosophy is the product of his experiences, permit me to use, as an introductory documentation, a few brief sketches of actual, recent contacts with engineering education and its end-products.

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I recently visited a Senior class in one of the accredited engineering schools, and was shocked to find that the individual students, shortly before graduation, were unable to answer my simplest questions on the work they were doing, although it was in their major subject. They were apparently producing a finished design by a routinized set of instructions, and their minds were a blank on the elementary, essential concepts underlying their work. Yet in two months these young men were going to be turned out upon the world as having completed an "*engineering education.*"

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One of the three examination papers given by the New York State Board of Examiners of Professional Engineers covers the basic engineering sciences which are supposed to be taught to all engineering students, generally in their Junior year. A wide selection of questions is offered, and the candidate is asked to answer only eight out of sixteen. Free use of all textbooks and reference books is allowed in the examination. The questions are prepared by engineering teachers, and the engineering educators of the state have approved this examination as eminently fair. Nevertheless *more than half* of the engineering graduates who take this examination are unable to pass it! A few years after graduation these

* Presented at the 48th Annual Meeting, S. P. E. E., University of California, June 24–28, 1940.

young men prove themselves *ignorant of the basic fundamentals* they were supposed to have mastered in their college years.

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A young candidate for a Professional Engineer's license was recently questioned by the New York State Board of Examiners concerning his past involvement in a matter of questionable professional relations. He was surprised to learn that the things he had done were violations of all the published Codes of Ethics of the profession, and he told us that he had never heard of professional ethics at college and had never seen a Code of Ethics before or after graduation!

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A prominent engineering educator—a past President of S. P. E. E.—was proudly telling me that he was finally going to start a system of student selection at his school. I was thinking of the high standards of the medical schools, in which it is practically impossible for a young man to secure admission unless he stood in the top quarter of his class in his pre-medical college courses; and it was therefore quite a let-down when this engineering educator outlined his plan for selective enrollment: Any high school graduate who stood in the *bottom* quarter of his class at high school would be required *to present a letter from his high-school principal!*

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Commenting on the low level at which most engineering schools start their curricula, with algebra and trigonometry taught in the Freshman year, I recently suggested to an engineering educator that, as a first step of progress, completion of high-school mathematics should be made a prerequisite for enrollment in engineering. He shuddered at the thought. He would be willing to go along with me, he said, to the extent of viewing such requirement as a long-range ultimate objective, but any thought of taking early steps toward that objective would be vigorously protested!

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The other day a seedy-looking stranger timidly approached me on the street, begging for the price of a meal. A brief conversation developed the fact that he had studied engineering at a well-known university in the class of 1920. As he clasped my hand in stammering gratitude, there flashed through my mind the fine-sounding phrase recently penned by engineering educators for their guidance literature: "Engineering training will add power, understanding, and enjoyment in almost any walk of life."

The very next day an engineer called at my office, begging, as he put it, "not for a position but for a job"—any job to keep him from starving. He graduated in 1911 from one of the largest engineering schools in the country, had knocked about from job to job, was now staying at a lodging place for derelicts, and had only nine cents left to his name. (All of this was A.D. 1940, not 1932.)

* * *

If the foregoing vignettes of actual personal experiences and contacts were unique or isolated, you might say that they prove nothing; but they can be multiplied indefinitely. I have selected but a few that reflect directly on some of the facets of the problem of engineering education. To me they are significant and revealing. I believe they raise some serious questions to stir our complacency with the present picture of engineering education.

Are the engineering schools properly fulfilling the high trust reposed in them by the public and by the profession? Are they maintaining adequately high standards of selection and guidance of students, of true education, and of full preparation for a professional career? Are they progressively raising these standards to meet the increasing requirements of educational equipment for professional lifework? Are the engineering educators using their best energies for the advancement of these standards, or are they instead using their energies and resourcefulness in rationalizing and justifying compromises and evasions that prevent or retard progress?

Shall the program of education for the engineering profession continue to be geared to the lowest standards of high-school graduation, or shall it be geared to a desired end-result in terms of professional education and preparation? Must the engineering schools accept every high-school graduate who applies, however ill-qualified or ill-prepared?

Is there something sacrosanct about a four-year period of education after high-school graduation to which the engineering schools must cling at all odds regardless of overcrowding of curricula, inadequacy of scope, and serious limitations and shortcomings of the end-result?

## Correction of a Misapprehension

In order to clear the atmosphere, I want to start by correcting a misapprehension that has been widely circulated in S. P. E. E. circles. I want to state, clearly and unequivocally, that *I do not advocate and have never advocated a numerical limitation of student enrollment.* I do not know of any group that is advocating

numerical limitation of engineering enrollment. Despite my repeated protests and attempts to secure correction, my name has become identified with this hypothetical proposal; and the use by S. P. E. E. spokesmen and others of such phrases as "arbitrary limitation" and "numerical restriction" only serves to aggravate this prejudicial misrepresentation.

My position on this general subject, as I have recorded it in my published articles, is as follows: *I believe that the competitive drive of engineering schools for student enrollment should be discouraged. I further believe that the standards of admission into the engineering schools and of qualification into the profession should be progressively raised.* These measures are necessary to raise the quality, the standards, and the standing of the profession. If, as a secondary concomitant, these measures result in a reduction of the oversupply of engineers, such reduction should be welcomed, since an oversupply (at the sacrifice of maximum quality) in any profession is not conducive to the best ethical standards, self-respect, professional pride, high service, and public regard. There is a distinction between *welcoming a reduction* and *advocating a limitation,* and I am sorry that some engineering educators appear to be unable to grasp this distinction.

My views on this subject are shared by many in the profession, and are clearly recorded in the following resolution unanimously adopted at the 1938 annual convention of the National Society of Professional Engineers:

*Resolution No. 1*

*Policy of N. S. P. E. Concerning Student Enrollment*

*Be It Resolved,* by the National Society of Professional Engineers, in Convention assembled at Pittsburgh, Pa., on October 19, 1938, that the following is the affirmed policy of the Society concerning student enrollment in the engineering schools:

1. Although it believes that the engineering schools are enrolling and turning out prospective engineers in numbers beyond the capacity of the profession to absorb, the National Society of Professional Engineers is not asking for any arbitrary limitation of the number of students admitted to the engineering schools.

2. The National Society of Professional Engineers does advocate and urge quality selection of prospective engineering students on the basis of superior preparation and aptitude.

3. The National Society of Professional Engineers does advocate and urge a progressive raising of the level of qualifications for admission.

## Prime Essentials

I believe that the criteria and the objectives of our engineering schools should be qualitative, not quantitative. *Quality, not quantity, should be the measure of success.*

I believe that the two prime essentials of any worth-while educational institution are *teachers*—highly qualified, gifted, and inspiring—and *students*—properly prepared, motivated, and capable. Given these two essentials, all such factors as endowment, equipment, laboratories, and even curricula are secondary considerations.

## Selection of Teachers

I believe that there is too much inbreeding in our engineering schools. The natural tendency for a school to select teachers from its own immediate graduates should be resisted and discouraged.

An associated evil is the engagement or continued retaining of teachers who have had little or no real outside experience in professional practice. The students are thus deprived of necessary elements of professional education—the practical applications, the engineering approach, the training of engineering judgment, the background of experience, the inspiration of achievement, and the professional viewpoint.

The New York State Board of Examiners of Professional Engineers will not accept mere teaching as satisfactory qualifying experience, but insists upon a reasonable amount of actual outside experience in engineering practice. In maintaining this requirement, the Board feels that it is doing a service to the teacher, the students, the school, the profession, and the public.

In addition, it should be realized that preparation for a teaching career is not necessarily identical with preparation for engineering practice. A broader educational base should reasonably be expected than is now generally required for engineering degrees. Adequate preparation for a teaching career, among other essentials, should include the study of educational psychology, of teaching methods, and of the history and philosophy of education.

Finally, how many of the teachers in our engineering schools really know how to teach? How many of our engineering teachers know how to inspire the students, to teach them to think, to make them grasp and retain fundamental concepts, to train their engineering judgment, to stimulate their originality and resourcefulness, to give them the professional viewpoint, and to inspire them with high ideals and a love for the profession?

Until all these things are considered in the selection of teachers, and not merely undergraduate proficiency or graduate degrees, engineering education will be found wanting.

## Selection of Students

There is little hope of raising the standards of engineering education as long as the schools obstinately cling to their belief that it is their duty to admit any graduate of any high school, however lacking in aptitude, preparation, or capacity. It may be true that some of the "Land Grant" colleges are under statutory requirement to accept any high school graduate, but that does not necessarily mean direct admission into the engineering school of the university, nor does it mean that all other engineering schools are under similar compulsion to keep their standards down.

The enrollment of any student lacking in aptitude, preparation, or capacity is an injustice to the student, to his classmates, to the school, to the profession, and to society.

The charter of the Engineers' Council for Professional Development, adopted upon formal organization in 1932, records the following as the first of the four major planks in its program:

> "(*a*) To develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that *only* those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members."

I have italicized the word "only," because it is the most important word for interpreting the intent and for gauging the sincerity of this program. With that word, the program means *selective enrollment;* without that word, the program means *enrollment promotion.* Euphemistic phrasing may obscure, but cannot change, this distinction.

I hereby challenge the E. C. P. D. to show its sincerity with respect to carrying out this announced program. The engineering educators are in control of E. C. P. D., and I predict that no program of selective enrollment will ever be recommended by E. C. P. D. The word "only" will be tacitly forgotten, and the meaning and purpose of that program will thereby be perverted. E. C. P. D. has an opportunity to demonstrate its honesty and good faith by proving my prediction to have been wrong.

In line with the four cardinal divisions of its program, E. C. P. D. has four standing committees, the first of which is the "Committee on Student Selection and Guidance." In its first annual report, this committee reported its conclusion that "Selection" was impracticable, and that its activities were to be concentrated on "Guidance." It has become virtually a "Committee on Student Guidance"—guidance *into* the engineering schools. It is all part

of the program—including the distribution of promotional literature, addressing high-school students and their parents, and running "vocational guidance" camps—to stimulate additional enrollment in the engineering schools. Every suggestion of "Student Selection" is met with alibis, and is put off with a far-fetched quest for "aptitude tests" and "correlation coefficients."

## Prerequisites for Admission

The obvious solution, appealing to common sense and conforming to the very foundation of all engineering study, would be to require all enrollment applicants to pass a college entrance examination in mathematics and physics. It is difficult to conceive how a student can profitably spend his four years in an engineering school without a preliminary mastery of at least these two high-school subjects. Of all pre-college studies, physics and mathematics are the most important and indispensable preparation for engineering study and application. The lack of this preparation must inevitably hold back proper progress in the engineering curriculum. The limited time in the usual four-year engineering course is too precious to spend in teaching elementary foundation subjects that should be thoroughly covered in the secondary school preparation.

In response to my repeated recommendations along this line, the chairman of the E. C. P. D. Committee on "Student Selection and Guidance" wrote me: "No doubt, you are correct in stating that mathematics and physics are the foundation subjects for all engineering curricula. . . . If we were to require high school physics for admission, it would necessitate a general agreement amongst the engineering colleges that this was necessary. *If one college required physics and others did not, the former would be faced either with a reduced enrollment* or with the acceptance of students who were deficient in physics. At the time of the investigation it was found that a considerable number of institutions admitted students deficient in mathematics. I hope and believe that the engineering colleges have moved forward from that position and that few are admitted who are deficient in mathematics." (The italics are mine. There is the crux of the problem. Competition for enrollment is always the first consideration, rather than the standards of the profession.)

It is also argued that the engineering schools can teach physics better than the high schools, but what a deplorable waste of time this is in the crowded four-year curriculum! A course in college physics is generally given in the sophomore year, but it has to start from scratch and proceed on a more elementary plane to accom-

modate those students who have not had the preparation of a course in high school physics. Less ground can be covered. The more advanced students are retarded, and the others do not make up for their handicap. The published report of the 1934–35 College Physics Testing Program clearly shows the marked difference in results on the Coöperative Physics Tests (measuring achievement in college physics) as between the students who studied physics in high school and those who did not. As the report states, "The group that studied physics in high school is consistently at or above the national average, while the other group is consistently below." This report also confirms the high correlation between proficiency in physics and engineering ambition or aptitude. As stated in the report, "Fig. 6 indicates, quite within expectations, that the group looking forward to engineering is higher in physics than any other pre-professional group. . . . The differences, after discounting all vitiating factors, are large enough to be suggestive of guidance possibilities."

The medical schools require all candidates for admission to have completed two, three, or four years of pre-medical study at a college of liberal arts and, as an additional requirement, to show specified numbers of credits successfully completed in college physics, college chemistry, college biology, physical chemistry and organic chemistry, before matriculation. Mastery of these *College* courses is established as part of the prerequisites for admission. The engineering schools hesitate to require even high school mathematics and high school physics. The individual school fears it will lose in the competition for enrollment if it adopts even these elementary and obvious standards. In the medical profession, the educators had vision and led in the progress toward higher standards and standing; in the engineering profession, the educators are resisting and retarding that progress.

## Progressive Raising of Admission Standards

It is not my intention to be critical save for constructive objectives. With this thought, and with a full realization of the limitations of any individual approach to the problem, I offer as a basis for further consideration a rough outline of a possible program for the progressive raising of the standards of admission to our engineering schools. With each upward step in the pre-admission requirements, there would be a corresponding raising of the curricular and educational level within the engineering school. In such program, the following standards and prerequisites for enrollment might *successively* be adopted:

1. Standing in the upper half of the class in high school.
2. Completion of high school mathematics, including trigonometry.
3. Completion of high school physics.
4. Completion of high school chemistry.
5. Standing in the top-quarter of the class in high school mathematics and high school physics (or chemistry).
6. Passing of college entrance examinations in high school English, mathematics, physics, and chemistry.
7. Satisfactory completion of one year of pre-engineering study in the scientific course of a college of liberal arts and sciences, including successful completion of such specified subjects as analytical geometry.
8. Satisfactory completion of two years of pre-engineering study in the scientific course of a college of liberal arts and sciences, including successful completion of college physics, college chemistry, and calculus.

This tentative outline is, of course, subject to modification and improvement, and alternatives may be suggested. At the present indicated rate of progress, it may take many years or many generations to reach the goal I have set out. When it is reached, engineering education will still be far behind the standard now already attained by medical education.

## Student Guidance

Under the guise of "student guidance," over 85,000 copies of "Engineering—A Career—A Culture" have been distributed by E. C. P. D. to high school students. With the title now changed to "Engineering as a Career," a revised draft has been prepared by engineering educators for distribution by E. C. P. D. Allure, inducement, and persuasion are still emphasized, and anything that may deter enrollment is avoided. Apparently those connected with the engineering schools cannot overcome their deeply rooted habit of enrollment propaganda.

In justice to the prospective students and to the entire educational picture, what is needed is an objective and factual picture of the qualifications for a professional career and of what is in store for the prospective engineering graduate.

I believe that guidance literature should contain clear and emphatic paragraphs on "Who Should *Not* Study Engineering." This phase is now conspicuous by its absence.

I believe that guidance literature should scrupulously avoid allurement by misleading pictures of prospective monetary returns. I tell young men that no student should choose engineering as a career unless he knows in his heart that engineering is the only

calling for him, despite the prospects of inadequate and uncertain material rewards.

I believe that the spectacular and the romantic should be avoided in presentations to prospective students and that instead they should be led to understand the nature of the severe discipline ahead of them and to make their decision with their eyes open to the realities.

I believe that those lacking in aptitude, capacity, preparation, ambition, determination, and strength of purpose should be diverted to other callings and other educational programs.

Because I am opposing enrollment propaganda and am advocating the diversion of the unqualified, I have been attacked and assailed by the engineering schools.

One educator attacks the idea of "ploughing under" future engineers. The surplus of engineering graduates are not future engineers. They are now "ploughed under," after graduation, by ruthless economic forces. It would have been elementary human charity to let them face the hard fact before enrollment instead of after graduation and to divert them to other callings before they devoted the four best years of their lives to study for a profession which they will never practice.

Sixty per cent of the students who enter our engineering colleges fail to graduate. Is not this equally a "ploughing under" of future engineers? One educator admits: "A number of poor students manage to struggle along in classes of capable students and finally pull through and are offered to the world as engineers." Then is selective guidance a heresy and are the acceptance and graduation of the incapable a virtue?

Another educator eloquently declares that "No boy with a God-given desire and ability to become an Engineer should be denied the opportunity." No one is proposing that any boy thus divinely qualified should be kept out. Any boy with a "God-given desire" will find his way in, despite any hurdles that may be set up; that type does not need any proselytizing or "vocational guidance" to induce him to apply for engineering school enrollment. And any boy with the "God-given ability" will not be kept out by any entrance examinations or aptitude tests that the educators will plan and conduct. It is the opposite type, without engineering ambition and aptitude, who should be diverted to other callings—as the best thing for these young men, their fellow students, and the profession as a whole.

## Present Curricula

The present curricula of most engineering schools are, to me, a source of keen disappointment. Not only have these curricula

failed to advance in line with increasing demands upon the educational equipment of the engineer, but in some respects there has been retrogression. Substitution, juggling, and shuffling of courses do not and cannot solve the problem so long as the schools cling to their low admission standards and to the arbitrary limitation of a four-year course of study after high school.

The average engineering-school graduate is not only an illiterate in English, economics, the humanities, and the social sciences, but he is also generally weak in mathematics and the physical sciences, sketchy in his understanding and grasp of his major branch of engineering, and extremely limited or ignorant in the other branches of engineering.

The first two years of the usual "engineering" curriculum are essentially pre-engineering. That cannot be otherwise when the students start with algebra and trigonometry in the freshman year, get their first course in physics in the sophomore year, and do not and cannot reach analytical mechanics until the junior year. This leaves only two years or less into which to crowd an engineering education. It simply cannot be done with any satisfactory results.

Natural and logical sequences of courses are sacrificed and upset by the enforced crowding of the curriculum.

The concentric principle of education—repeating an important basic subject on a higher level, with broader scope, and more intensively—has to be foregone.

Inclusion of the essentials of other branches of engineering is reduced to the vanishing point. The graduate in civil engineering is generally ignorant of thermodynamics, power, machine design, and electrical equipment; and the graduates in mechanical and electrical engineering are generally ignorant of stress analysis, structural design, and foundations.

Within each major branch of engineering, important courses that should be a part of the educational equipment of the graduate have been crowded out of the curriculum and are now available only to post-graduate students. The student is led to believe that he will get a complete engineering education in four years, and then upon graduation he is told that if he really wants to complete his education he must come back for more. I am not referring to more advanced, abstruse, or independent studies for the few, but rather to studies that have been and should be included in the regular curricula and the lack of which leave a gap in the technical equipment of the graduate. For example, a graduate in civil engineering who has had no courses in soil mechanics, foundations, rigid frames, and indeterminate structures, has not completed his technical education. More advanced and intensive studies in these fields are

properly post-graduate, but first courses in these subjects belong in the undergraduate curriculum.

Pre-engineering courses, mathematics and the basic sciences, general engineering courses, adequate intensive preparation in a major branch of engineering, adequate courses in the related branches of engineering, English, economics, the humanities, the social sciences, human relations, industrial and financial relations, professional ethics and practice—how can all these things be crowded into a curriculum limited to four years after high school? The answer is—they cannot!

## Lengthening the Curriculum

As far back as 1903, when the suggestion was made to a prominent member of S. P. E. E. that it might be well to extend engineering courses to five years, the reply was, "Young man, if you want to lose your job, just suggest a five-year course at your university."

After a number of universities had adopted five-year courses in engineering, the trend of progress was checked by an adverse report of an S. P. E. E. committee on this subject in 1927, and now again in 1940.

Here and there, an engineering school has been courageous enough to adopt a five- or six-year curriculum, or to arrange for one or two years of pre-engineering college work. Most of the engineering schools, however, have throttled any suggestion to raise their curricula toward a truly professional or graduate school level, preferring to remain on the lower plane where they could compete with the arts college, the forestry school, or the school of agriculture, for student enrollment.

On this subject, one educator writes: "Prominent schools have adopted five- and six-year courses and have had to drop them, for they could not *compete* with schools of equal prominence that held to the four-year course. It would seem that there is little possibility of a long curriculum proving successful until all of the important schools of the nation make a concerted move for such a course." Again, competition for enrollment appears as the governing consideration, rather than perfection of the educational training and its product.

I can see no alternative. The present curriculum is both inadequate and over-crowded. The curriculum must either be lengthened to five or six years, or must start at a higher level if only four years are to be spent in the engineering school.

## Broadening the Base

For years many of us have been urging a broadening of the base of engineering education. As "a voice crying in the wilderness," we have been pleading for a liberal education for the engineer, that he may better meet the changing and widening demands of society upon his capacity for service and that he may take his proper place among educated men in professional and public life.

I am not proposing that our engineering students be asked to study Latin and Greek, although such distinguished members of our profession as Michael Pupin and Hardy Cross have borne high testimony to their indebtedness to those studies.

But I am asking that the educational base for our engineering students be broadened beyond the technical, to include those liberalizing studies that will help our graduates to take their place as educated men and as members of an educated profession.

Our students need English (not merely "engineering English"), including literature, composition, and mastery of lucid and effective writing. And, with this, effective speaking must be included.

Our students need economics (not merely "engineering economics"), that they may have a more discriminating understanding of social, economic, and political trends, and a better grasp of the social and economic implications of their professional work.

Our students need to study history, government, contemporary civilization, philosophy, logic, aesthetics, industrial relations, human relations, psychology, professional ethics, and other subjects not ordinarily included in the engineering curriculum. Such studies are indicated not because they are educationally more valuable than the strictly technical, but because *they are needed to complement the technical in the educational preparation of a professional man.*

Engineering educators now admit and recognize the validity of this educational philosophy. The S. P. E. E. Committee on "Aims and Scope of Engineering Curricula" now declares in its conclusions:

> *"Undergraduate curricula should be made broader and more fundamental through increased emphasis on basic sciences and humanistic and social studies."*

I take my hat off to the Committee for its courage and vision in reaching and recording this conclusion. Whether the engineering schools, to an appreciable extent, will do anything to effectuate this recommendation, is another question.

## A Logical Sequence

It should be accepted as axiomatic that the members of a profession should be truly educated men.

If the engineering profession is to be a profession in the highest sense of the word—a profession of planners and leaders and not of mere technicians—we need education, and not merely technical training.

I believe that *education,* in its foundation essentials, should precede training; and that *general education and training* should precede *specialization.*

My picture of professional preparation is that of the pyramid—for breadth, soundness, and enduring stability—*First, as a broad base, the education that all educated men should have; then the basic courses that all engineers should have; and finally, the more specialized and intensive training for the major branch of engineering selected.*

The logic is that of progressive preparation and specialization, with advancing intellectual maturity for decisions affecting choice of life-work and for the more intensive preparation therefor.

All of this cannot be done in a course of study limited to four years after high school. The engineering educators virtually admit that their four-year curriculum does not complete the necessary schooling for the professional man, and they prescribe or suggest post-graduate courses to cover the deficiency.

For a complete program of professional preparation, based on the developing logic of the situation, I would recommend the following sequence:

1. *Two years of pre-engineering college study,* at the level of the present first two years of the engineering school, to include college physics, mathematics through calculus, and other basic requirements that may be indicated; this to be taken either in the engineering school or in the scientific or pre-engineering course of a general college, preferably in the latter.

2. *Two years of general engineering* in the engineering school, at the present third and fourth year level, with more emphasis on basic engineering and less attempt toward specialization; with the degree B.E. conferred at this stage.

3. *Two years of study in a major branch of engineering,* in an extended and coördinated program in the engineering school; with the degree of the type B.C.E. conferred at this stage.

This program, I submit, meets all of the problems of engineering education. It makes preparation for the profession the governing, though not the sole, objective. It provides three terminal points,

at each of which the student retains full flexibility for further decisions, with advancing maturity for each more critical decision. It provides two degrees to be conferred by the engineering school: one upon completion of the program in general engineering, for the man who wants to stop at that point; and another upon completion of the full curriculum for the man who has selected the major branch of engineering in which he plans to practice. It enables the engineering schools, if they have the vision to do so, to turn the first two pre-engineering years over to the colleges of liberal arts and sciences, and to concentrate upon their true function —*the teaching of engineering* through the general and professional levels. It enables the engineering schools to plan and develop a coordinated and adequate *engineering* curriculum of four years above the pre-engineering level.

## General Engineering

For years I have been advocating that the first degree in engineering be simply B.E. (Bachelor of Engineering), on the ground that there cannot be, or should not be, enough specialization in the first four years after high school to justify specialized degrees. In 1932, the same recommendation was independently made by President Butler of Columbia University. In 1936, Yale adopted this principle, and President Harvey N. Davis of Stevens recorded his conviction that the trend in engineering education will be increasingly toward a single curriculum in general engineering. There are already six curricula in general engineering on the accredited list, with several others, including the new "Basic Engineering" course at Princeton, awaiting official approval.

In a recent address, President Davis said: "Specialization in undergraduate engineering education has its disadvantages and dangers. In the rapidly changing world in which we live, adaptability is increasingly more important to the young college graduate than is an academic proficiency in any one limited field of engineering. . . . Is it not wiser for a prospective engineer to devote his first four years to studying unhyphenated engineering, just as prospective doctors study medicine, and prospective lawyers study law?"

## Pre-Engineering College Education

Now that it is agreed by the engineering educators that the education of engineers should contain a liberal content of humanistic-social studies, that the first four years after high school should not attempt to go beyond the introductory fundamentals of engineering, and that further years of engineering study are needed to complete the educational preparation for professional practice, the

underbrush has been cleared away and we can proceed with greater clarity, efficiency, and mutual understanding to consider other phases of the problem.

Let us now address ourselves to the question of the first two years after high school. Since physics and calculus are not reached until the second year of the present engineering school curriculum, and since these subjects are prerequisites to the study of the basic engineering sciences (such as hydraulics, thermodynamics, statics, dynamics, and mechanics of materials) and these in turn are prerequisites to the first real engineering courses, it should be obvious that *the first two years after high school are essentially pre-engineering years.* They contain little, if anything, that is not obtainable in the first two years of a scientific course in a general college. Any increase in their content of humanistic-social studies, as recommended by the S. P. E. E. Committee, will further reduce any remaining difference. *Then why not give the option of taking these first two years in a college of liberal arts and sciences?*

*For the student,* this would have the advantages of:

1. Postponing, to greater intellectual maturity and educational experience, a critical decision on choice of lifework.
2. Saving the student from a sense of failure and frustration if he decides, during this period, that engineering is not the career for him.
3. Giving the student, during his formative years, broader contacts with different types of personality, different viewpoints, and different fields of interest.
4. Giving the student a better opportunity to study and compare other domains of knowledge, other types of thinking, and other fields of activity.
5. Giving the student certain valuable intangibles of college life that are associated with the traditional college and that are somehow unfortunately missing from the conventional engineering school atmosphere.
6. Giving the student an opportunity to find himself, to get his feet on the ground, and to learn to study on the collegiate level, before he enters upon the more serious work of intensive professional training.

*For the engineering school,* this plan would have the advantages of:

1. Relieving the engineering school of much of the burden of sifting and screening to assure aptitude, ambition, preparation, and capacity.

2. Relieving the engineering school of much of the present high mortality of students who fail to make the grade in study at the collegiate level, who lack the persistence and determination, or who otherwise find that engineering is not the career for them.

3. Relieving the engineering school of the pressure to accept high-school graduates of inadequate preparation and aptitude.

4. Relieving the engineering school of the problem of adjusting curricula downward to meet the varying and frequently inferior standards of high school preparation.

5. Relieving the engineering school of the necessity of largely duplicating the curriculum of the first two years of the scientific course in the general college.

6. Relieving the engineering school of the necessity of devoting most of its time, resources, personnel, and energy to teaching the courses of the first two years after high school.

7. Freeing the engineering school to concentrate on its essential function, *engineering education*.

8. Facilitating the development by the engineering school of a sound, coördinated four-year program of engineering education above the pre-engineering level, with a degree in General Engineering at the end of two years and a degree in a major branch of engineering upon completion.

*For the profession,* this program would have the advantages of:

1. Raising the level of engineering education to that attained by other learned professions.

2. Providing a complete, coördinated program of educational preparation for the future members of the profession.

3. Providing the profession of the future with men broadly educated and thoroughly trained, equipped for leadership, constructive vision, and technical achievement.

*For the public,* this program would have the advantages of:

1. Saving the economic and human waste of disappointed ambitions, misguided selection of careers, half-qualified preparation for professional lifework, and narrowness of background, social orientation, and human relations.

2. Saving the economic waste of competition of schools and duplication of curricula.

3. Securing engineers more broadly educated and more thoroughly trained for public leadership and high professional service to society.

We are not discussing here the relative merits of "horizontal" or "vertical" stratification in the educational program. The en-

gineering schools are left free to carry the "humanistic-social stem" up through the four years of engineering study to such extent as they may deem desirable.

We are not arguing here the relative merits of a liberal and a strictly technical education. It has been agreed that a combination of both is necessary and desirable.

The combination does not necessarily involve a loss of time for the student, since he has to spend two years, either in the engineering school or in the general college, in order to complete physics, calculus and other pre-engineering studies before he can start on his real engineering studies as now given in the third year of the engineering schools.

I do not know why there has been such a hue and cry raised by engineering educators against the suggestion that the two years of pre-engineering education might be taken in the general college instead of in the engineering school.

All I can do is to repeat my plea to engineering educators for fair consideration, professional vision, and an open mind.

## The Function of Engineering Schools

In the recent report of the S. P. E. E. Committee on "Aims and Scope of Engineering Curricula," the statement is reiterated that the engineering colleges "should not limit their aim to preparing young men for professional registration and practice." That phrasing dodges an issue. No one is asking the schools to *limit* their function to preparation for the engineering profession. What we want to know is why the engineering schools do not recognize preparation for the engineering profession as *their primary and paramount function.* We want to know why the program of *engineering education* is not designed and proportioned for this primary function of preparation for professional careers, instead of being diluted, weakened, retarded, and confused, with other functions, that should be secondary, cited in justification.

The medical profession has its medical schools, the legal profession has its law schools—and the engineering profession is entitled to have its engineering schools, conceived, planned, and dedicated to professional preparation as their essential and primary function.

The S. P. E. E. Committee report recommends that engineering courses now in the curriculum be transferred to the postgraduate period, and suggests that "preparation for the higher technical levels of engineering" must be found in such postgraduate courses. As I interpret this, the four-year curriculum of the conventional engineering school is to be diluted into a pre-engineering course, all

pretense that it is adequate preparation for professional lifework is to be given up, and the graduate is then to be told that if he wants a real engineering preparation for his chosen profession he must find it in such post-graduate courses as may be offered.

If this philosophy is carried out, the "engineering school" will be little more than another general undergraduate college course, majoring in science and mathematics, and flavored with a sprinkling of introduction to engineering. The designation "engineering school" will then be a misnomer in any professional sense, and *the problem of providing a comprehensively planned, coördinated, and adequate program of preparation for the engineering profession will not be solved.*

I want to see the engineering schools realize that their *primary* function is the training of the *engineers* of the future.

The engineering schools now claim that they have a three-fold function:

1. The training of technicians.
2. The training of engineers.
3. The training of "executives."

To cover this wider range, the educators have recently devised a new phrase—the "Engineering Fraternity," as something vaguer, larger and more inclusive than the "Engineering Profession." I believe that this phrase tends to obscure the issue and will retard real progress. It is an evasion of the focal problem of designing an educational program for the training of *engineers.*

The present claimed necessity of training technicians, professional engineers, and non-professional "executives" in a single curriculum leads to compromise, dilution, and inadequacy of the educational program and to a lowering of standards.

All are agreed that the training of technicians should be relegated to trade or technical schools. We need more such schools. Following the recent inauguration of E. C. P. D. accrediting, some of the schools that had been doing a fine job of vocational training decided to lengthen their courses to the orthodox four-year pattern in order to qualify as engineering schools. (This undesirable development is now being blamed on engineering registration. As usual, any good accomplished by E. C. P. D. accrediting is credited to E. C. P. D., and any untoward results are charged to registration.)

The development of more vocational schools for the training of technicians should be encouraged, and more of the applicants for engineering school enrollment should be diverted to such vocational schools. The world has need for good surveyors, draftsmen, inspectors, laboratory assistants, trained machinists, operators, and

service men; but the professional school is not the place for training them.

Nor is there any valid reason why the training of professional engineers and non-professional "executives" should be identical. The respective educational programs may properly overlap, but there should be an appropriate differentiation of intensity and scope, particularly after the pre-engineering subjects are covered. The non-professional "executive"—the man who will have some contact with engineering or construction without undertaking engineering work himself—does not require the full intensive technical training of the engineer. On the technical side, beyond an introduction to the basic sciences and the scientific mode of thought, the non-professional "executive" needs to know little more than the nomenclature of engineering.

In order to make my thoughts on this subject concrete, and as a basis for further discussion, I offer the following program of education and training for the three fields of lifework:

1. *For the Technician*—After high school graduation, two years in a good vocational school, with graduation recognized by a diploma.
2. *For the Engineer*—After high school graduation, two years in the *scientific course* (or pre-engineering course) of a college of liberal arts and sciences, followed by two years of *general engineering* in an accredited engineering school (at approximately the present third and fourth year level) with the degree B.E. conferred at this stage, and finally two years of more intensive training in the selected *major branch of engineering* in the engineering school with the degree of the type B.C.E. conferred upon graduation.
3. *For the "Executive"*—After high school graduation, four years in the *scientific course* of a college of liberal arts and sciences, receiving the degree B.S., followed by two years of *general engineering* in an accredited engineering school (at approximately the present third and fourth year level) with the degree B.E. conferred at this stage.

I believe this is a logical differentiated program to take care of the three categories of training with which the engineering schools now consider themselves charged. It involves a raising of the level of engineering education to a truly professional level.

The indicated successive degrees are merely a suggestion. To me they are of minor importance, but I have inserted them merely to answer the questions of educators who are insistent on "terminal points."

## Accrediting of Engineering Schools

When registration laws made it necessary for the several states to have lists of approved engineering schools, the National Council of State Boards of Engineering Examiners began to formulate an accrediting program for uniformity of standards. The engineering educators, fearing that such program might get out of their control, seized the opportunity afforded by the formation of E. C. P. D. to launch the E. C. P. D. accrediting program.

With the first round of inspections and reports completed, we find that engineering curricula in 118 schools have been approved by E. C. P. D. Long before this, the New York State Education Department had developed its own procedure of appraising, inspecting and approving engineering schools for the benefit of professional registration, and has found engineering curricula in only 95 schools meeting its standards. E. P. C. D. would enlarge this number of accepted schools from 95 to 118. I do not call this a raising of standards.

The earlier reports of E. C. P. D. accrediting gave some encouragement to hopes of a genuine effort to distinguish between standard and substandard schools; but in 1939 the E. C. P. D. Committee examined or re-examined curricula in 50 engineering schools previously omitted, turned down, or provisionally accredited, and approved all for accrediting except one or more curricula in four of those schools. The E. C. P. D. list now includes a number of schools that have generally been regarded as substandard. Elimination or rejection has been avoided, provided the school made any reasonable showing of the Procrustean pattern of a four-year curriculum. The only curricula in which a commendably high standard has been maintained for accrediting are those in chemical engineering; and that is because the American Institute of Chemical Engineers reserved to itself the decision on these courses, instead of turning them over to E. C. P. D. to lower the bars.

In my years of contact with E. C. P. D. accrediting, I have heard much about physical and financial conditions and about minor adjustments or comparisons of curricula, but have heard little or nothing of the two most important considerations, namely *the quality of the teaching* and *the mastery of engineering concepts and methods by the students.*

In the questionnaire filled in by the engineering schools, which is the first thing studied by the accrediting committee, the first four headings out of a total of nine relate to Organization and Administration, Physical Plant and Facilities, Finances (including administrative salaries and teaching salaries), and Staff Salaries,

Tenure, and Retirement. After the first round of E. C. P. D. accrediting, it was common to meet engineering educators engaged in mutual felicitation on the fine results achieved in terms of additional teaching appointments and increases in salaries.

E. C. P. D. accrediting, although conducted in the name of the seven participating societies, is handled almost exclusively by the engineering educators. There is a sprinkling of practicing engineers on the committees, but this appears to be largely for window-dressing; the actual participation of the non-educators is much smaller than their inclusion in the printed list would indicate.

That the end-product of accredited engineering schools does not reach any uniformly satisfactory minimum standard of educational equipment and understanding is sadly revealed by the oral and written examinations of state registration boards. Until accrediting is made a genuine sifting and screening operation, the educators cannot consistently continue their demand that the graduates of accredited schools should be blindly accepted as educationally qualified without further examination. Failure to make accrediting what it should be will undo much of the progress that has been won in writing recognition of engineering education into the registration laws. Testing of the end-product—the graduate—by comprehensive examinations administered by state registration boards will become the criterion rather than the mere fact of graduation from an accredited engineering school, and E. C. P. D. accrediting will lose its significance.

## Engineers' Registration

Engineering educators have obstructed, or have failed to cooperate with, the engineers' registration movement. I do not know why. Charge it to ignorance or to characteristic resistance to progress. "Shall Engineering be a closed profession?" is the issue they have raised. They do not realize that registration has done more than anything else to establish engineering as a *learned* profession, with emphasis on professional *education* as an essential prerequisite. Registration is making it more and more difficult for men to get into the profession through the backdoor route without an engineering education. In 1929, the New York State Registration law contained no requirement of education or examinations. Now both are written into the law. Moreover distinct recognition has been recorded for the approved colleges of engineering: The relative handicap imposed upon the non-graduate, in terms of the longer qualifying experience required, has been progressively increased from two years to eight years. Finally, the examinations are such as virtually to bar those without proper professional edu-

cation. The educators have tacitly accepted these advantages, but have shown little recognition or coöperation in return.

Recent graduates, facing registration problems, have asked me: "Why were we told nothing about registration at college?" I could give no answer. I do not know why there should be an apparent conspiracy of silence or ignorance. An educator is sadly remiss in his duty to his graduating students if he does not inform them of the established requirements for securing admission to the profession. The young graduate may be seriously handicapped if he lacks such information and guidance for the proper planning of the apprenticeship experience and the continued post-collegiate study required to round out his professional training and to qualify him for registration.

## Registration Examinations

Individual educators have retarded progress in developing the examination standards for engineers' registration by saying to the Boards of Examiners: "We do not want you to re-examine our graduates!" They protest when examinations are included in subjects that are given in their curricula, and they protest again when examinations are included in subjects not covered in their curricula. It is difficult to understand why an educator should object to an impartial objective comparative test of his graduates with those of other institutions or with candidates who have not had the advantage of a college education. It is still more difficult to understand why an educator should object to examinations that test a candidate's knowledge matured and ripened by experience and supplemented by continued self-education four or more years after graduation. In the other established professions, as medicine and law, opposition by educators to extended qualifying examinations for licensure would be unthinkable. For engineers' registration, the State wants to test the candidate's knowledge and attainments at the time of professional certification, and is not satisfied to accept varying undergraduate class-room ratings antedating graduation as an equivalent substitute.

Despite the generally recognized narrowness or other defects of certain approved curricula, the Registration Boards are *not* "telling the educators what to teach." They are, however, expecting the graduates of these schools to make up for any shortcomings or limitations in their education by further study after graduation. Surely the educators cannot quarrel with this principle. On the other hand, the teachers should not seek to tell the Registration Boards what examinations to give. Mutual coöperation and counsel are desired, but dictation is out of place. The

Board of Examiners is entrusted with a serious responsibility by the State, and cannot delegate that responsibility to others.

## Conclusion

All that has been said in the foregoing is intended as sincere constructive criticism. It is presented with all due respect for the many educators who have exemplified, in their lives and in their work, the highest qualities of self-sacrifice, vision, and leadership in genuine coöperation with the ideals and the aspirations of the engineering profession.

# WIDENING OPPORTUNITIES OF ENGINEERING INSTITUTIONS TO CONTRIBUTE TO PUBLIC WELFARE *

By EDWARD L. MORELAND

Dean of Engineering, Massachusetts Institute of Technology

When I was invited some months ago to be one of the speakers at this meeting I chose my subject because I felt a reëxamination of the obligations of our engineering institutions to serve the public welfare was timely. In two recent studies competent authorities had appraised the aims and scope of our well-established educational functions, and we had reached a juncture in our planning where we could afford a look beyond our more obvious activities toward our exceptional opportunities as institutions devoted to public service.

The mounting catastrophe in Europe and our resulting awakening to the necessity of prompt preparedness for adequate national defense, by enormously intensifying the opportunities and obligations for exceptional service, now makes this reëxamination urgent as well as timely. I propose, therefore, to consider our opportunities for public service not only in terms of normal conditions but in the light of the national emergency.

To an extraordinary degree, our national strength is now dependent upon the capacity of the engineering profession. This capacity is not solely a matter of technical competence and organization. If the profession is adequately to meet national needs, it must be free of the petty parochialism of the guild, it must think and act in terms of national unity and the public weal. It must be unselfish, broadminded, coöperative, and statesmanlike. We have heard much in recent years of the professional spirit and of the qualities that distinguish a profession. Engineers as a group must now reveal whether they have this spirit and these qualities. If these words and adjurations have a familiar and homiletic ring, I present them without apology. They are appropriate to the exigent responsibilities which we face.

These responsibilities of the engineering profession apply equally to engineering educators and suggest the task confronting the engineering schools. Certainly we cannot expect practicing engineers

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to be any more coöperative or broadminded or unselfish than are we who are engaged in engineering education. Certainly, too, the attitude of our young graduates toward their responsibilities to society is influenced by their contact with us. If this be not true, if we are not having any effect on their outlook on life and on the development of their sense of responsibility, then we are missing the greatest opportunity of all.

Coming now to the specific opportunities of engineering institutions to contribute to the public welfare, I suggest three major categories of service: the training and placement of men, the mobilization of our staffs for service as experts, and the organization of our research facilities.

## The Training and Placement of Men

In preparing engineers for their careers, we should not overlook opportunities for placement in the normal public service, local, state and national. There is a natural inclination to think of engineering as associated mainly with industry and private enterprise and to overlook the rôle of technology in government. By the same token, there is perhaps a certain amount of deprecation of government service, despite its grave responsibilities and its resultant need of men with high technical qualifications and a well-developed sense of social responsibility.

By way of emphasizing their multiplicity and diversity let me recall some of the scientific and technological responsibilities of the simplest government unit, the municipality. These include water supply, sewage disposal, public health, inspection services, building codes, traffic control, in many cases air-port operation, in some cases municipal utility systems, park administration and planning, signal systems, including radio control of police cars, city planning, large-scale housing, and many more. In this complex of technical activity competence is of prime importance to the public welfare, and there are major problems awaiting solution. In the reform of our archaic building codes, and their adjustment to modern design and materials, for example, there is challenging work for engineers. In the ordering of our limping public housing programs, there are opportunities still more challenging. I know of no government undertakings that so badly need the curative and prophylactic administration of sound engineering as public housing and attendant problems of city planning.

On the higher levels of government, state and national, this complex of technology increases vastly and reaches deeply into the most fundamental aspects of national life and policy. The extent to which the government can command expertness in these mani-

fold fields of technology and engineering administration is a determining factor in our social evolution.

These conditions offer the double opportunity and impose the double obligation upon engineering institutions of giving our students adequate training for public careers and of developing means to promote a flow of more first-rate men into government service. A collateral problem is to develop in the minds of our better students a greater awareness of the opportunities in public service and of the importance to our national life of having really first-rate men in public service. In other words, we need to cultivate the idea of career service in public life. Under present conditions, government activities certainly need the best men that can be had from the engineering schools. Moreover, I believe that the conditions of government service are now such that we are justified in encouraging our good men of suitable temperamental characteristics to enter that service.

The wide range of opportunities in government service is indicated by the fact that a recent announcement of Civil Service examinations for Junior Engineers and other specialists specified twenty-eight categories for which examinations would be given. Quite aside from present emergency conditions, the Federal government can absorb approximately a thousand technically trained men each year in the junior grades alone.

There has been a pronounced tendency for the government to look to the law schools for recruits, particularly for positions associated with policy-making functions. There has been a traditional bias here, of course, but there has been at the same time more interest in government service on the part of the law schools and the legal profession.

There is growing evidence that a realization is spreading in government circles that men with engineering backgrounds can bring a special and essential competence to administrative and policy-making posts. We need to encourage and support this tendency, particularly by preparing men for, and directing them into, the forecasting and planning functions of governmental agencies.

The Federal Civil Service authorities are keenly alive to the situation and have gone out of their way to cultivate the colleges and engineering schools. They are anxious to get the help and advice of the placement officers of the educational institutions on how to attract the best men for government work.

One simple way by which we can be of great help to the government in the selection of technical men is by refusing to recommend any men for government service who are not properly qualified. We should remember that these men may ultimately be in important supervisory posts and may play formative parts in the

development of governmental regulation and control. The Civil Service certainly should not be made the dumping ground for men not good enough for industry.

In my own institution, our contact with the Civil Service recruiting officers convinces us that they are doing a good job within the limitations imposed on them. They need all the help they can get from the engineering schools and are ready to take it.

The present emergency will enormously increase the demand for technical men in the government service. Of equal importance is the demand it will create for technical men to speed up production in the industries essential to the national defense programs. Part of this industrial demand will be met by programs initiated by the government and we have already heard, through the U. S. Commissioner of Education and the N. Y. A., something of the plans under discussion in Washington involving training in a wide variety of technical services. We, of course, stand ready to respond to these requests in a wholehearted and aggressive way. At the same time, we may hope that in the planning of these special programs adequate consideration will be given to the level of training for which the engineering institutions are best qualified. We do not want to divert our special abilities and facilities from advanced work important to national defense. The emergency may demand otherwise, but I believe we can be most effective by concentrating on engineering training at the college level rather than on trade-school courses. Here is an immediate question of policy that should be studied intensively by engineering educators.

The needs of industry, however, will not be met wholly by government-sponsored training programs, and the engineering colleges can on their own initiative organize and offer special courses. They can offer, for example, intensive courses for the training of inspectors of materials and supervisors. Here it may sometimes be possible to draw students from fields of engineering in which the demand is not great and equip these men by intensive courses for work in engineering fields where there is a shortage. We might, for example, train civil engineers for work in the aeronautical industry.

Below the level of professional engineering training, some institutions, especially well equipped for such service, might offer intensive training in arc and flame welding, and preliminary training in machine tool work and foundry practice, thus helping to meet the shortage of workers in these fields by shortening the period of apprenticeship in the shops.

Many such opportunities unquestionably exist, and if the head of each engineering department in all our engineering schools gives constructive thought to what his department is able to do in the

training of special personnel, I am sure that the sum total of the possibilities will be an impressive program of assistance to national defense.

### Services by Expert Personnel

Another major opportunity lies in the services of our staff members as paid experts in many fields. Under the present emergency conditions there are many such opportunities to serve government agencies as experts in planning or carrying through the activities associated with the national defense program. There will be even more opportunities to serve industries essential to national defense. Some such opportunities of serving governmental agencies or essential industries will always exist but in normal times the greater opportunity for staff members to serve the public will come through voluntary, non-paid service on local or national committees of governmental bodies, professional societies, and civic organizations. These services, even when on a purely local scale, are important in three major respects; first to the organization served because they make available to the organization the counsel of trained men; second to the institution with which the man is connected because they tend to develop closer and more cordial relations between the institution and the community and to close the breach between "town" and "gown" which unfortunately frequently exists to a greater or lesser degree; and finally to the individual concerned because of the opportunity it gives him to meet and work with men of other interests and experience and to broaden his contacts and point of view. Service of this kind may be on standing committees or on special committees appointed for specific purposes. Such service offers excellent opportunities for the younger members of the staff to make contacts outside of academic circles and to get a different type of experience. In this connection, service on committees of the national engineering societies may properly be counted as for the public welfare. If my belief as to the place of the engineer in our national scene is justified, anything that benefits the profession and particularly anything that aids in establishing engineering on a high professional level, is for the public good. There are many such opportunities for service, and staff members should take full advantage of them.

In this area of voluntary public service, there is one specific kind of activity that warrants mention. In several regions of our country, public spirited citizens are forming organizations to promote industrial activity and the economic development of their region. The efforts are being undertaken not only to promote industrial activity and employment, but in recognition that this form of community and regional initiative is much more desirable than

the temporary palliatives of government aid and appropriations for relief.

One example of this regional activity is the New Products Committee of the New England Council, the objectives of which are:

1. To hasten the development of new products within New England or for New England industries.
2. To determine whether there are additional resources within the area that may be developed profitably.
3. To mobilize the industrial research facilities.
4. To assist the manufacturer, and particularly the small manufacturer, in utilization of organized research.

Obviously, these objectives rely to a great extent upon engineering methods, and engineers are voluntarily taking an important part in the program. Some of the most active of these are on the staffs of engineering institutions and are members of this Society. This type of effort is a challenge and an opportunity to public-spirited educators to make a lasting contribution to their communities.

Governmental authorities, both local and national should be encouraged, by ready response, to call on educational staff members for aid and advice. The unhappy experience of the national government with some of the university professors called in on its political and social problems in recent years may after all not have been the fault of the universities but of unfortunate choice of individuals. The experience with technical experts from our institutions on scientific problems has been distinctly more fortunate. This participation in public affairs is growing as engineers develop a more defined professional attitude with its accompanying emphasis on public service. It may be noted that there are an increasing number of institutional representatives on government boards and special committees. Outstanding examples are the National Advisory Committee for Aeronautics and the special advisory committee for the Weather Bureau. The work and methods of the Weather Bureau are being revolutionized by developments coming from scientific institutions. Many temporary committees to aid in the solution of special government problems and formed through the agency of the National Research Council of the National Academy of Sciences and through the American Engineering Council have drawn experts from our institutions. This type of public service, because of its powerful influence and its disinterestedness, warrants the utmost encouragement.

Under the present emergency conditions, opportunities for personal service by staff members are certain to increase. If men from our educational staffs are not wanted to help plan and speed

the national defense programs it is a clear indication that we in administrative positions have not been picking the right type of men.

### Organization of Research Facilities

The final great opportunity of our engineering institutions to make technical contributions to the public welfare lies in their unusual facilities, in equipment and personnel, for vital research. The Experiment Stations associated with many of the State universities have long been doing splendid work particularly for the smaller local industries, both by giving technical advice and by conducting research to solve the particular problems facing the industries. The Agricultural colleges also have done much in improving agricultural efficiency, but there are still many undeveloped opportunities not only for these special agencies but for the technical laboratories of our institutions in general. The larger institutions in particular have staffs with wide ranges of experience and special training and, in some cases, have special equipment which enable the institutions to attack research problems which the commercial laboratories and the governmental agencies and industry itself are not equipped to handle. This is true even in normal times, and under the present emergency conditions the opportunities for helpful coöperation with government agencies or with essential industries will unquestionably be greatly increased.

As examples of the type of research that educational institutions are conducting with the coöperation and support of governmental agencies, I might mention researches directed toward increasing the safety of air-transport, including such developments as "blind" landing of airplanes at airports; methods of preventing the formation of ice on airplane windshields and propellors; aids to ship navigation in fog, including means of detecting the presence and the direction and distance of other ships or fixed obstacles. A particularly interesting example of a coöperative program with a government agency is work which M. I. T. has been carrying on with the Federal Weather Bureau. For several years they have been sending to us each year several of their men to work with our Meteorological group on the development of methods of long-range weather forecasting. This coöperation has served the double purpose of furthering the research in which the Weather Bureau is greatly interested and of training the Weather Bureau personnel in the methods which have so far been developed. We have more recently begun a similar coöperative attack on the problem of forecasting thunder storms. Similarly, as examples of research for the public good, would come work with hospitals and medical schools in the development of methods and equipment, including

high-voltage x-ray units for cancer-research, instruments for detecting the presence of minute quantities of radium in the living tissue, development of the technique of following radio-actively "tagged" atoms injected into the blood stream as an aid in studying the flow of blood and the functioning of organs of the body, development of electrocardiographs, pulse counters and other instruments for medical or hospital use, research on the cause and elimination of anesthetic explosions in hospital operating rooms, and a long line of researches in the field of nutrition and public health.

While the opportunities for research of this type may be greater in the large institutions, and especially in those located in or near large centers of population, they are by no means confined to such institutions.

There are matters of broad policy in relation to research which call for study. Should the government set up centralized laboratories of its own for war research, or should it utilize institutional laboratories operating under a coördinating body? We have in this country today the largest number of adequately equipped and adequately staffed laboratories in the world—how might they be utilized to the fullest as a great resource?

Should the government withdraw for its own use the scientific staffs of our educational institutions, or should it allow institutions to retain their integrated staffs as creative units coöperating in a broad plan? Should our institutions seek to keep their creative personnel intact and, if so, what methods of liason and coördination might they develop? The recently created Research Committee for National Defense under the Chairmanship of Dr. Bush may help answer many of these questions. In the meantime we may well consider how we might organize research assigned to us. Certainly we should inventory our resources available for war problems, list the problems which could be studied effectively, and poll our staffs to determine their special abilities and experience, while at the same time we are seeking answers to these questions.

So far I have spoken primarily of the opportunities to serve the public welfare in technical capacities. There is, however, another opportunity for our engineering institutions which must still command our attention, namely, the educating and training of our young people for citizenship, and in this connection I pause to emphasize some old verities because they now have a new significance.

In the face of alien doctrines and the disturbances of war, public service demands undiminished effort in directing our young people into a smooth adjustment to their professional environment.

In helping pave the way for our graduates to become useful

citizens, there are some things we ought to do for them to a greater extent than we are now doing. First we ought to do more to cushion the shock of transfer from school life to industry. Fortunately a good many of our students now have summer jobs during the later years of their college careers and so learn something of the atmosphere they are going into after graduation. There are still many students, however, who have not the remotest idea of what they are going up against and to these the complete change often comes as a real shock which leaves a period of bewilderment and discouragement. If we could somehow eliminate this shock, or at least minimize it, we would be doing an important service.

Second, the colleges ought to insist on employers recognizing the job they have to do in educating and developing the young recruit. We know that we can only begin the educational process and that the success of the young graduate probably depends more on the experience and guidance he gets during the first few years after college than on what he gets in college. We recognize this and industry should be educated to recognize it. The difference due to the handling of young engineers during the first few years after graduation shows up very clearly in our experience with employers who take some of our graduates year after year. Some of these employers always get a high percentage of "hits" as judged by results a few years later, while others have only average success, or less. Something may be due to shrewdness in picking their men, but we believe the major difference is in the way they develop their raw material after they get it. If we can educate industry to a general appreciation of this fact, it will be very helpful. Again, we ought to insist that industry be realistic in specifying the characteristics of the men they really need; we should refuse to accept the over-inflated specification that what is wanted is the type of man "who in ten years could be president of the company." Industry has places for all grades of men with sufficient intelligence to complete a rigorous engineering course and they should fit their specifications to their real needs.

On the other side, the placement bureaus of the colleges ought to be set up so that when they get realistic specifications they can let the "ivory hunters" see the type of men they really need.

Still farther back, the public and particularly the parents of prospective college students, need to be educated to the fact that for success in engineering work, or even in engineering studies certain aptitudes are needed. Many parents are so anxious not to interfere with the free development of their offspring that they sit silently and watch them head toward some field that the parents ought to know they are not intellectually or temperamentally qualified for. If the youth seems to head naturally toward a field for

which he is not qualified or toward a field where the future is very definitely limited, it is better that he be diverted young rather than disappointed later.

Last of all, but in my mind by no means least important, we need to do all we can, especially in these troubled times, to help the young men and women in our colleges to get a sound philosophy of life and a sound understanding of our national ideals and traditions. We need to do all we can, consistent with full adherence to the fundamental doctrine of freedom of speech and freedom of thought, to see that our students have the necessary background from which to judge the outpourings to which they are subjected by the various pressure groups. I have great faith in the fundamental soundness of judgment of our youth of today and particularly of our engineering students, and I am not at all afraid to leave to them the acceptance or rejection of radical doctrines provided they are shown both the obverse and reverse side of the medal. I believe the students are entitled to know the philosophies of the older and more experienced, and perhaps the more conservative, members of the body politic as well as of the advocates of more radical or leftest doctrines. It seems to me that there has been a tendency for the conservatives to lean so far back in recognition of the doctrines of freedom of speech and thought that they have let the alien isms do all the talking and influencing.

In conclusion I venture a concrete proposal. The National defense program is already bringing the engineering schools within its orbit, and there is immediate need to examine the functions which they can best perform either under present conditions or under a more acute emergency. I propose that this Society as representative of the engineering institutions undertake to focus the ideas and suggestions which are forming in the staffs of the member institutions, to explore the scope and directions of our special activities, and thus to assist all in planning their defense activities with maximum effectiveness. I have mentioned only a few of the problems and opportunities, and I hope the forum provided by this conference is utilized to the fullest advantage in clarifying the situation which we face. Above all, S. P. E. E. should throw the full weight of its influence towards the development of a centralized coördinated program of effort by the educational institutions, and against the development of conflicting programs by competitive organizations.

We are confronted with an immediate and pressing call to public service that demands our unremitting attention and that recalls with urgent emphasis the poet's dictum that "New occasions teach new duties."

## EMERGENCY TRAINING

This is an edited combination of reports made at different times during the Convention, to the Council and to the Society.

By O. J. FERGUSON
President

The last of May, the U. S. Office of Education was asked to make tentative plans by which colleges of engineering throughout the country could coöperate with the federal authorities on national emergency training. Dr. Kelly was asked to prepare immediately a brief statement of what he thought colleges might do. He had two hours to prepare this. Following that he was given 24 hours to formulate a statement of plans on which he based his estimate. In consultation with two members of his staff and the deans of three engineering colleges in Washington, a statement was prepared which was submitted to the President of the United States.

On June 5–6 a meeting was called at which Secretary Bishop represented the Society. At this meeting the following statement was prepared. It was sent by this Society to all deans of engineering schools.

Our Nation faces the problem of mobilizing all facilities available for national defense. Of crucial importance now is the quick and efficient preparation of an additional supply of trained persons in those occupations essential to national defense.

The American people have already made an investment of one and a quarter billion dollars in more than 1,200 vocational and technical schools and colleges throughout the country. The program of trade and technical education which this investment makes possible is carried on by an experienced administrative organization and a staff of 35,000 skilled teachers. The facilities for defense training now provided by these schools and colleges could not be duplicated in many years.

These schools and colleges, now operating in every State in the Union, can make greater use of their present plants and equipment to turn out trained workers. If funds are made available, these institutions can expand their programs immediately through additional shifts in late afternoon and night periods and in summer sessions. By giving many of the workers intensive short courses—in some instances requiring only a few weeks—these institutions can train at least 1,250,000 workers annually, thus more than doubling their normal training capacity.

This expanded program can be put into operation immediately if Federal funds are made available. In our judgment the greatest efficiency can

be secured by administering this program through the established Federal, State, and local educational agencies in close coördination with the agencies responsible for the national defense.

Signed in Washington, D. C., June 6, 1940, by:

CARROLL REED, Superintendent of Schools, Minneapolis, Minnesota, President American Association of School Administrators, *Chairman,*

F. L. BISHOP, University of Pittsburgh, Secretary, Society for the Promotion of Engineering Education,

WILLIAM G. CARR, Secretary, Educational Policies Commission, Washington, D. C.,

D. W. CREEL, Assistant Secretary, Association of Land Grant Colleges and Universities, Washington, D. C.,

L. H. DENNIS, Executive Secretary, American Vocational Association, Washington, D. C.,

WILLARD E. GIVENS, Executive Secretary, National Education Association, Washington, D. C.,

B. E. PACKARD, Commissioner of Education, Augusta, Maine, Secretary, National Council of Chief State School Officers,

S. D. SHANKLAND, Executive Secretary, American Association of School Administrators, Washington, D. C.,

R. O. SMALL, State Director of Vocational Education, Boston, Massachusetts, President, American Vocational Association,

A. J. STODDARD, Superintendent of Schools, Philadelphia, Pennsylvania, Chairman, Educational Policies Commission,

JOHN J. TIGERT, President, University of Florida, Gainesville, Florida, President, National Association of State Universities.

On June 13 another meeting was held in the Office of Education and President Ferguson and Assistant Secretary McKenry represented the Society. At this meeting there were representatives from the Army and the Navy, twelve colleges, and the Association of Land Grant Colleges and Universities. The representatives from the Army and the Navy stated that their departments would train their own technicians through enlisted personnel.

Emphasis was placed on the fact that the regular college work of engineering colleges was not to be interrupted; that emergency training was to be an additional activity.

It was recognized that the emergency training would call for two levels of work, sub-collegiate and collegiate and post-collegiate. Vocational schools could handle the sub-collegiate work and the engineering schools the collegiate and post-collegiate.

With the development of technical institutes, night schools, vocational schools of the past 20 years, we are in an entirely different situation from what we were 23 years ago when the emergency training program of the first World War came up. And it

PROPOSED TRAINING PROGRAM FOR NATIONAL DEFENSE IN SCHOOLS AND COLLEGES

| Facilities to be used | Number to be trained | Average length of training period | Hours of training per week | Cost | Average cost per trainee |
|---|---|---|---|---|---|
| *A. Public Schools* | | | | | |
| Summer schools 1940 | 150,000 | 10 weeks | 40–42 | $15,000,000 | $100 |
| Extra shifts during the regular school year | 225,000 | 12 weeks | 40–42 | 27,000,000 | 120 |
| Expanded trade extension programs for employed workers | 375,000 | 36 weeks | 4 | 21,600,000 | 57.60 |
| Total for *Public Schools* | 750,000 | | | 63,600,000 | 84.80 |
| *B. Engineering Schools* | *20,000 | 10 months | 40–42 | 14,000,000 | 466.67 |
| *C. Expansion of Facilities Requiring Capital Investment* | 250,000 | 10 to 36 weeks | From 4 to 42 | 50,000,000 | 84.80 † |

* This number (20,000) can be trained for 10 full months. Probably many persons to be trained in these colleges would need only three or four months of intensive training. The total number of *different* persons who may be trained for $14,000,000 would therefore equal approximately 30,000.

† Exclusive of capital investments.

is felt that these secondary schools can, to a very large extent, accommodate the situation for training in sub-collegiate levels.

It is also recognized that at this time the importance of collegiate and post-collegiate training has increased, and that the natural deduction from these two facts is that engineering colleges as such should not strain themselves to do sub-collegiate work, but should protect their facilities for post-collegiate and collegiate work to whatever extent that can be done effectively. That does not, however, inhibit colleges able to do both, from doing both.

Congress has passed a bill appropriating $15,000,000 for sub-collegiate work, and recommendations for collegiate training have been deferred because of the lack of time and the feeling that the greater emergency of immediate action pointed toward the short-term work.

Mr. Kelly expressed himself as wishing that this Society might study the facilities of its member colleges for coöperation in emergency defense training.

The American Council on Education has drawn up and presented to the President of the United States a statement, "Education and the National Defense," which seeks to define the fundamental principles of coöperation between education and the federal government in relation to national defense and which recommends the setting up of appropriate arrangements to carry out these principles. The President has authorized the appointment of a committee including representatives from eleven governmental agencies. Council appointed a committee including representatives from twelve national educational organizations. C. C. Williams, Lehigh University, represents this Society on this committee.

A meeting was held on June 24 at which conscription and a program of specialized training for increasing industrial activity were discussed. The committee went on record as favoring compulsory service to begin at the age of 21. Also, barring a military emergency, any compulsory training for ages 18 to 20, inclusive, should be supplementary to rather than supplanting regular school and normal economic engagements for those so employed. Also that existing educational facilities should be utilized rather than building up new ones under NYA or other sponsorship. The committee expressed the desire that the S. P. E. E. would formulate a statement of the kinds of things colleges of engineering might do in the way of intensified special effort to promote national defense.

(A meeting was held July 8–9 but unfortunately President Williams was unable to attend.)

Assistant Secretary Creel, Association of Land Grant Colleges and Universities, wrote President Ferguson as follows: ". . . While state directors for vocational education will probably contact presidents of Land Grant colleges and state universities without undue delay, I think it would speed matters up if the heads of our engineering schools will promptly advise the state directors of the extent to which their institutions are prepared to coöperate in the present program."

Secretary Snavely, Association of American Colleges, wired D. B. Prentice, President of Rose Polytechnic Institute: IN VIEW OF PROPOSALS BEING MADE TO CONGRESS YOUR COMMITTEE ASKS TELEGRAPHED OPINION ON FOUR QUESTIONS: FIRST: COMPULSORY MILITARY TRAINING FOR MEN 21 TO 45. SECOND: COMPULSORY NON MILITARY BELOW AGE 21. THIRD: DEFERMENT OF SERVICE FOR PERSONS TRAINING FOR MEDICINE, DENTISTRY, CHEMISTRY, PHYSICS, ENGINEERING WHERE THIS IS CLEARLY NECESSARY FOR NATIONAL WELFARE. FOURTH: DEFERRED SERVICE IN ANY OTHER EDUCATIONAL FIELD ESSENTIAL AND IF SO WHAT?

That completes the statement that I can make to you this morning. It emphasizes the point that has been apparent to me all

through these conferences, and these communications, namely, that regular engineering instruction should not be crippled. It is recognized that it is one of the most important elements in the preparation for national defense, and that participation in sub-collegiate work should not be allowed by engineering schools to interfere with their possible participation in collegiate level work. Again, it is presumed that in the very near future we shall know more about what collegiate work, collegiate level work, and post-collegiate level work can be afforded and will be asked for by the Federal Government.

The Council took the following actions in regard to the emergency training program: Deemed it unwise to appoint a special committee. It was the consensus that better results would be obtained if the coöperation of the Society in matters pertaining to national defense is left in the hands of the President and the Secretary, thus centralizing responsibility. These officers were instructed to keep the engineering schools fully informed of developments.

The Council also authorized the Executive Committee to call a meeting of the Council at any time they deemed it advisable.

## NATIONAL COMMITTEE ON RELATIONSHIP OF EDUCATION TO DEFENSE

On July 15 the National Education Association called a meeting of twenty-four organizations at which President Prentice and Secretary Bishop represented this Society. The following statement was unanimously adopted:

"We, as executives of national organizations interested in public education, declare our concern in making plans for total national defense, especially as they affect youth and all phases of education. To that end we recognize the necessity of the immediate establishment of a democratically constituted national committee on the relationship of education to defense. We therefore hereby request the National Education Association and the American Council on Education, through their executive officers, to organize such a national committee to be composed of one representative of each of the major national educational organizations—this representative to be selected as soon as possible by each of the several organizations but in the meantime to be one of the executive officers thereof.

"The purpose of this committee will be: (*a*) to advise and cooperate with the United States Office of Education and any and all other governmental agencies interested in education; (*b*) to keep the educational organizations of the United States informed as to problems relating to education and defense; (*c*) to use the co-

operative thought of the various organizations and the members thereof; and (*d*) to coördinate all educational efforts toward national unity."

On August 22, 1940, an Operating Committee was organized and Secretary F. L. Bishop was appointed a member of it. The first meeting is called for September 6, 1940.

## NORMAL COURSE IN EDUCATION ADVISED BY THE PRESIDENT

On August 14, 1940, President Roosevelt wrote Paul V. McNutt, Federal Security Administrator: "Reports have reached me that some young people who had planned to enter college this fall, as well as a number of those who attended college last year, are intending to interrupt their education at this time because they feel that it is more patriotic to work in a shipyard, or to enlist in the Army or Navy, than it is to attend college. Such a decision would be unfortunate.

"We must have well-educated and intelligent citizens who have sound judgment in dealing with the difficult problems of today. We must also have scientists, engineers, economists, and other people with specialized knowledge, to plan and to build for national defense as for social and economic progress. Young people should be advised that it is their patriotic duty to continue the normal course of their education, unless and until they are called, so that they will be well prepared for greatest usefulness to their country. They will be promptly notified if they are needed for other patriotic service."

## RELATION OF ENGINEERING COLLEGES TO NATIONAL DEFENSE

By B. M. WOODS
University of California

I had the experience on Monday of attending the first meeting of the California State Council of Defense, and several things happened at that meeting which are likely to happen at similar meetings throughout the country.

Naturally the subject that received a great deal of consideration was that of the so-called Fifth Columnists; espionage, sabotage, and subversive activities, so-called, are matters of grave concern to all of us. Therefore, it was, I think, highly important that at the meeting the subjects received specific attention.

A representative of the F.B.I. for the Region centering in San Francisco presented a brief report and a definite recommendation. He reported that on September 6, 1939, the President of the United States had referred to the F.B.I. this entire question; that the F.B.I. had taken immediate steps to coördinate its work and its indices of persons with the law enforcement agencies in all of the states and all localities. The aid of all law enforcement agencies has been sought and is being received. The F.B.I. urges first that anyone who has information or suspicion of such activities report the matter to the nearest law enforcement office.

In the second place, that on no account should he or any agency voluntarily undertake any investigation. There have been a number of instances in which well laid plans of law enforcement agencies for the apprehension of offenders and action have been practically ruined by the voluntary efforts of busybodies. And so the recommendation made is that no person or agency do any investigating, but report and get the matter off his mind.

It was reported that a good deal of injustice is being done to law abiding citizens. That is something to which we should give serious thought; suspicions on the part of people who have no basis of knowledge are not proper bases of action.

There was considerable discussion, of course, of the industrial mobilization plan. I think that every one of you should have a copy of that plan in a skeleton form, and a discussion of it. The plan itself is published. It is Senate document 134 of the last session of Congress, the 76th Congress, the second session. It is called "The Industrial Mobilization Plan, Revision of 1939." It may be had from the Superintendent of Documents for 10 cents. It is a brief statement of a plan of organization to utilize the industrial resources of the country and other resources in time of need. It is the result of more than fifteen years of study of this problem on the part of Army and Navy officers, in conference with leaders of industry and governmental officials generally.

It represents a considered plan to avoid the confusion of the last war in the United States in industry. It has been reported that in the last war industrial production declined, beginning in 1916, and did not again reach the 1916 level until the war was over. If that were to happen in current activities, it would be a major calamity—as it was then.

The major recommendation of this report is the organization of a War Resources Administration. No matter what the name of it may be, that is, in effect, what is being undertaken. The major methods to be followed in securing full production through industry are four. First is the use of priorities. Priority is the name given to the process whereby given types of orders in pro-

curement are put ahead of other things. By agreement on priorities in a general way it is possible to accelerate a large number of decisions, so that production can start at once on the things which are known and officially assigned as priorities.

Second is the control of prices Some suggestions are made as to possible need for control of prices and the manner of going about it. That is a complicated problem and somewhat out of the realm of the engineer.

Third relates to the control of foreign trade. These include embargoes and other common controls on trade, which would have an important effect.

Fourth is the organization of definite governmental corporations to undertake certain types of activities which it would be unreasonable and not feasible to ask of industry. There are some in which definite losses may be incurred, and in which guarantee of the losses is essential; some in which the inside knowledge of certain governmental activities is required which cannot be made generally public, some which cross governmental organization lines and cannot be undertaken by private industry. I think you will find it valuable to study this plan.

Incidentally, the whole subject is discussed from the layman's point of view in the July issue of *Harper's Monthly*. I think you will find that worth studying. It is called "M Day and the business man." It is the leading article in the current issue.

May I say a few words now in regard to coöperation of other colleges of engineering? Some of you undoubtedly will serve on the councils of State Defense. If not, you are likely to be advisers. The comments I have just made, I think, cover two very important relationships to those councils.

It is likely that in every case the State Council of Defense will do its best work if it remembers that it is essentially a body charged with investigation, with planning and with advising. I doubt very much whether it should become an administrative agency in any case. It will have to be administrative in the sense of carrying on its own business, but I mean with reference to other agencies. I believe it will have fewer difficulties and a greater influence if it restricts itself to the three problems of investigation—planning, reporting and advising.

Now for our engineering colleges I would like to emphasize one or two points. We have, in the industrial field and in the colleges, it seems to me, a short range and a long range program, which must go forward concurrently because of present deficiencies. It is therefore vital that production in industry shall proceed at once with current models of things. It also is very important that improvements shall not stop. So that in the short range program,

supplementing for a moment what was presented this morning by President Ferguson, it seems to me very important that we recognize the limitations of energy in our staffs. We are not likely to find it easy to increase our staffs in the next year or two with the type of men we want. We are likely to face subtractions among our keenest and most useful men. This is going to give us a severe problem of man power. I hope that we shall solve it in such fashion as to increase the strength of our staffs, because certainly the demands upon them will grow.

Now, the total energy of the staff is about so much. Let us come down to engineering terms. If among the many things that come to us we do not choose selectively and secure the aid of many other agencies for others, I fear that more confusion rather than less will result. I think particularly of the importance of utilizing such agencies as the junior colleges and the technical colleges; the junior colleges with their terminal curricula for all of the forms of training that can be done in those institutions. I think it is equally important that the universities and colleges of engineering remember that there is no institution above them, and consequently if they do not do the work they ought to do at the top, it will not be done. That to my mind is a very important consideration.

I think also it will be helpful if industry can be led to see the importance of doing a great deal of in-service training, of devoting a part of its energy to the training of personnel; and in that we may be of great aid in an advisory capacity.

I believe that a familiarization course, as you might call it, would be very helpful for a number of engineers who need to adapt themselves to new lines. It may have been mentioned at this meeting—I was not here all the time—that the California Institute of Technology has a special class of engineers now being trained in the technique of airplane design. These men have adequate fundamental training, but in a short course of eight or ten weeks they are given as much specialized training as possible to adapt them to re-employment. This is done in collaboration with one concern in the airplane industry. These men are working with that concern, or expect to work with it. That type of program, of course, we can wisely undertake.

I think also we shall be obliged to do short range research programs. I do not know if you realize that four years ago in Germany the departments of physics were told that they might do no more fundamental research in physics, that for the present the emergency there called for the utilization of existing knowledge, application to machines and other equipment, and that was to be stressed above everything else.

Now, that after all is engineering research, is it not? The adaptation of the latest results of pure science to industry, that is our problem. There will not be time for it initially, but it seems to me the long range program will call for (*a*) an immediate production program running, in airplanes, perhaps a year or nine months, during which there must be (*b*) a redesign of models and preparations of tools, dies, and so on for the next models, which should be a step upward.

Finally, I think we ought to remember that we must train some engineering statesmen,—as I believe we have done in the past,—men of very broad understanding. Patriotism will require in this emergency, as it required in the World War, a recognition on the part of young men, that those who are called to the direct service of industry or of the military constitute only a part, and that others must do other things. The college man must prepare himself. The young man entering college must consider his preparation for the future as being of equal importance, so long as he is not needed in the other immediate lines.

I heard President Wilbur, as you did yesterday afternoon, read the announcement made and endorsed by President Wilson in 1917, dealing with the importance of continued training. And if we are facing what may prove to be a generation of the national defense problem, it would be suicide to cut off the training of graduate students and to stop progress in these researches.

You may be interested in the reports that I had from Germany also, that during the first two years of the Nazi regime it was not considered red blooded to go on and take graduate work; you must go out and work for the party. But shortly the leaders discovered they could not fill the research positions in their laboratories. By official order of the Party, young men were sent in droves to take graduate work in the institutions, and to fill the laboratory and training positions. In one laboratory I was told they had all the equipment for all the men ready, including even the work aprons at the different benches, but the places were vacant because no man had yet come from the technical institute ready to do that job, and they would not fill it with a lower grade man.

Now, to train the man for the job represents a type of efficiency which democracy is challenged to equal, and I believe, as all of you do, that democracy is quite capable of meeting this challenge. But it means, as I see it, that the engineering statesman of the future will regard his task as one of bringing to complex problems the contribution that he can make. He will not fail to collaborate because of economic and political elements in the problems. He will welcome the opportunity to join with political scientist or

economist or government official to find sound solutions and to make contributions which may be vital to success.

Also, to gain efficiency, we must not permit misuse of democratic processes—such as blocking important lines of progress by small organized minorities. Efficiency in education, efficiency in industrial advancement have been attained to the highest degree by a democracy. There is no basis for lack of faith in efficiency within our democracy.

The future appears to me to be serious. It requires imagination and adaptability to meet its challenge. But why isn't this the opportunity for the engineering college to make the greatest and most substantial contribution in its history. We can participate in the national program to a greater extent than we have ever done.

## REPORT OF TREASURER, W. O. WILEY, FOR 1939–40

### Statement of Cash Account, June 5, 1940

| | | |
|---|---|---|
| **Balance on Hand—June 15, 1939:** | | |
| Forbes National Bank—Checking Account | $ 4,820.62 | |
| Forbes National Bank—Savings Account | 7,688.03 | $12,508.65 |
| **Receipts:** | | |
| Current Dues | $14,601.58 | |
| Back Dues | 1,762.50 | |
| Dues in Advance | 152.50 | |
| Sales of Publications | 479.88 | |
| Advertising | 2,228.11 | |
| Sale of Emblems | 85.25 | |
| Receipt from Committee on English for Printing | 400.00 | |
| Rebate from Lamme Medal Fund | 350.98 | |
| Interest on Savings Account | 115.75 | 20,176.55 |
| Total | | $32,685.20 |
| **Disbursements:** | | |
| Cost of Publications | $ 8,015.45 | |
| Cost of *Proceedings* | 272.40 | |
| Honorarium for Secretary | 2,000.00 | |
| Clerical Assistance | 4,000.00 | |
| Travel and Entertainment—Secretary's Office | 396.71 | |
| Committee Expense | 721.41 | |
| Printing, Postage, Office Supplies, etc. | 798.90 | |
| Expenses—1939 Meeting | 479.52 | |
| Expenses—1940 Meeting | 1,074.43 | |
| Dues—American Council on Education | 100.00 | |
| Dues—American Engineering Council | 250.00 | |
| Contribution to Engineers' Council for Professional Development | 600.00 | 18,708.82 |
| **Balance on Hand—June 5, 1940:** | | |
| Forbes National Bank—Checking Account | $ 6,172.60 | |
| Forbes National Bank—Savings Account | 7,803.78 | $13,976.38 |

### Society for the Promotion of Engineering Education

### Income and Expense Statement for the Year Ending June 30, 1940 (Prepared June 5, 1940)

#### Expense

| | |
|---|---|
| Cost of Publications | $ 8,815.45 |
| Cost of *Proceedings* | 272.40 |
| Expenses—1939 Meeting | 1,089.60 |

| | |
|---|---|
| Honorarium for Secretary | 2,000.00 |
| Clerical Assistance | 4,000.00 |
| Printing, Postage, Office Supplies, etc. | 798.90 |
| Travel and Entertainment—Secretary's Office | 396.71 |
| Committee Expenses | 721.41 |
| Dues—American Council on Education | 100.00 |
| Dues—American Engineering Council | 250.00 |
| Contribution to Engineers' Council for Professional Development | 600.00 |
| | $19,044.47 |
| Surplus for the year | 527.10 |
| | $19,571.57 |

INCOME

| | |
|---|---|
| Current Dues | $15,500.08 |
| Back Dues | 1,062.50 |
| Sales of Publications | 479.88 |
| Advertising | 1,928.11 |
| Sales of Emblems | 85.25 |
| Committee on English for Printing | 400.00 |
| Interest on Savings Account | 115.75 |
| | $19,571.57 |

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

BALANCE SHEET, JUNE 30, 1940
(PREPARED JUNE 5, 1940)

ASSETS

| | | |
|---|---|---|
| Cash: | | |
| Current Fund | $ 6,172.60 | |
| Petty Cash Fund | 300.00 | |
| Life Membership Fund | 849.88 | $ 7,322.48 |
| Savings Account: | | |
| Forbes National Bank—No. 3809 | | 7,803.78 |
| Benj. G. Lamme Trust Fund: | | |
| Securities and Mortgages | $ 4,966.88 | |
| Uninvested Cash | 149.25 | |
| Gross Income with Trustee | 106.60 | 5,222.73 |
| Prepaid Expenses—1940 meeting | | 1,074.43 |
| Inventory | | 1.00 |
| Accounts Receivable: | | |
| Advertising | $ 200.00 | |
| Dues | 700.00 | 900.00 |
| Furniture and Equipment (est.) | | 100.00 |
| | | $22,424.42 |

LIABILITIES

| | | |
|---|---|---|
| Life Membership Fund | | $ 849.88 |
| Benj. G. Lamme Trust Fund | | 5,222.73 |
| Prepaid Membership Dues | | 152.50 |
| Accounts Payable—May and June JOURNAL | | 1,600.00 |
| Surplus Account: | | |
| Balance at June 15, 1939 | $14,072.21 | |
| Surplus for present year | 527.10 | 14,599.31 |
| | | $22,424.42 |

## MINUTES OF COUNCIL MEETINGS

### June 24–28, 1940

*Present.*—O. J. Ferguson, D. B. Prentice, F. L. Bishop, A. H. White, C. E. MacQuigg, H. H. Armsby, C. A. Mockmore, J. S. Thompson, V. M. Faires, L. G. Straub, B. M. Woods, A. A. Potter, H. S. Evans, D. S. Kimball, R. A. Seaton, H. P. Hammond.

### EMERGENCY TRAINING

The facilities of the Society have been offered to the government in matters pertaining to the defense program, and your officers have been coöperating with the U. S. Office of Education, the American Council on Education, and the National Education Association.

**(See page 52 for complete report on Emergency Training)**

The Council will meet at the time of the meeting of the Association of Land Grant Colleges and Universities in the Palmer House, Chicago, Ill., November 11–13, 1940, the exact time to be determined.

The reports of the Treasurer, W. O. Wiley, and the Secretary, F. L. Bishop, were read and ordered printed.

R. A. Seaton, Chairman of the Committee on Institutional Membership, presented the following report:

"Within the past year, four institutions formerly holding associate institutional membership in the Society have qualified for active membership and have been transferred by vote of the Council to this latter classification. These institutions are: Alabama Polytechnic Institute, Northeastern University, Southern Methodist University and Vanderbilt University. Similarly, one institution, Howard University, was transferred from active to associate institutional membership.

"Six institutions not previously members of the Society in any grade were elected to active institutional membership: Pratt Institute, U. S. Coast Guard Academy, University of Tulsa, College of the City of New York, Thayer School of Civil Engineering at Dartmouth University, and Utah State Agricultural College. With the election of these new members only one educational institution in the United States eligible to active institutional membership in the Society is not now a member. It is hoped that it will apply for membership within the year.

"Two institutions, not previously members of the Society in any grade, were elected to associate institutional membership: Mississippi State College and Fenn College.

"The Committee has received the application for associate institutional membership from Franklin Union Technical Institute but it is not unanimously agreed as to whether technical institutes are eligible for such membership under the provision of the Constitution which requires that 'Associate members shall be other educational institutions giving instruction in engineering.' No definition of 'engineering' is given in the Constitution or the By-Laws, nor is there any specification of the amount or kind of instruction in engineering that is required. The Committee therefore desires instruction from the Council on this point."

It was the sense of the Council that technical institutes should be accorded associate institutional membership in the Society and that they be defined in the terms of the report on technical institutes of the Board of Investigation and Coördination. This definition is taken from page 4, Vol. 2 of the report of the Board:

> The key term is the common designation *technical institutes* for all post-secondary technical schools giving more intensive instruction than the four-year colleges. This category, as used in this report, does not include trade schools which train for manual crafts nor junior colleges which offer only the introductory half of a complete college course. The ground covered herein relates only to terminal courses, of a content equivalent to one or more full academic years and, while more purely technical than the courses of the engineering colleges, include a substantial treatment of the underlying sciences, drawing and usually some work in English and economics.

Franklin Union Technical Institute, in view of the above, was therefore recommended by the Committee and elected by the Council to associate institutional membership.

Council granted the petitions for divisions to industrial engineering and to technical institutes, the latter to be similar in membership to other divisions of the Society. The incoming officers of the Society are to appoint a committee on technical institutes to plan a program for the 1941 meeting.

It was the sense of the Council that, in order to release more papers for publication in the JOURNAL OF ENGINEERING EDUCATION, no division be given more than four pages a year. In the discussion of this motion, emphasis was placed upon the fact that four pages meant four pages and no more. Of course, this does not exclude the publication of papers which may be submitted for publication in the JOURNAL.

It was the sense of the Council that requests for pages in the

JOURNAL from individuals and not from groups should not be granted.

The Committee on Relation with Engineering Societies recommended that the 1942 meeting be held in New York City. The invitation of the institutions in the New York area was conveyed in a letter from Dean Jos. W. Barker, Columbia University. The meetings will be held at Columbia and the members housed there. The Council accepted this recommendation, and set the last week in June as the tentative date.

The invitation from the University of Texas to meet there in 1945 was received with appreciation but action deferred.

**New Committees.**—Council authorized the appointment of a Committee on Aeronautical Engineering; Committee on Procedure and Method of Nomination and Election of Officers and Members of Council; a committee to study the question of practicing engineers working on a salary basis with the question of labor unions. The Committee on Junior Colleges for 1940–41 is to be instructed to coöperate with the Association of Junior Colleges at the request of this group. The Committee on Aims and Scope of Engineering Curricula was discharged with the thanks of the Council.

The Executive Committee recommended to the Council that a special committee on relations of divisions to the Society be appointed to study the relationship and the matter of contributions in connection with constitutional statements and to bring to the Council at its next meeting a recommendation to guide the allocation of funds and the relation of divisions to the Society as a whole. President Ferguson appointed R. A. Seaton, Chairman, F. L. Eidmann, M. W. Furr, H. E. Dyche and H. M. McCully.

**American Council of Education.**—F. L. Bishop was elected for a term of three years as the representative of this Society.

**Engineers' Council for Professional Development.**—R. E. Doherty was elected for a term of three years as the representative of this Society.

Council appropriated $500.00 to E. C. P. D. for the work of the Committee on Engineering Schools.

Council approved the participation of the Engineering Institute of Canada in the work of E. C. P. D. and that its charter be changed accordingly.

Permission was given to the Drawing Division to hold a midyear meeting; to the Mechanical Engineering Division to have a conference at Purdue University following our meeting at the University of Michigan, June 23–27, 1941, for a review of progress since 1929; the conference to be without expense to the Society.

The terms Mr., Mrs. and Dr. are not to be used in the year book.

Council approved the following resolution adopted by the

**Mathematics** Division of the Society: In various parts of the country there seems to be a movement to postpone and to abbreviate the courses in mathematics given in the secondary schools. This movement apparently does not recognize the fact that those courses are essential prerequisites for the future training of scientific and engineering students, and that the university has not postponed and cannot postpone the mathematical or the scientific and engineering instruction in the university, if its graduates are to enter those professional fields. Moreover, at the present time, for our own defense as a nation, it is suicidal not to develop the most thorough kind of training for engineers.

The members of the Conference on Mathematics of the Society for the Promotion of Engineering Education wish to go on record as recommending that there be no postponement in the mathematical education in the secondary schools of those students who are to seek careers in science and engineering. In particular they feel that it is essential that a full four-year program of mathematics be available in the high schools for capable students, beginning with a year of college preparatory algebra in the ninth grade. They feel that this subject should not be postponed and also that thorough work in trigonometry and in solid geometry should be available.

This resolution in no way implies that university preparatory courses be required of all students. But this organization feels very strongly the importance of providing substantial courses in mathematics for those who need them in preparation for future work or for those who choose to elect them. We believe that to be effective these courses must begin with algebra at least as early as the ninth year, that is, the first of the last four years in the secondary schools.

M. L. Enger, Chairman of the Committee on Sections and Branches, presented the following report which was approved:

"A new section, to be known as the Southwest Section, is in the process of being formed. It will probably include Texas, Oklahoma, and New Mexico. The University of Oklahoma and New Mexico State College have voted to join with Texas. Oklahoma A. & M. College is giving consideration to joining with Texas, but has not decided upon its action. It is suggested that final action on the organization of the new Southwest Section and the abandonment of the Arkansas-Oklahoma Section be deferred until a vote is taken by the members of the Society in Oklahoma A. & M., University of New Mexico, New Mexico School of Mines, and New Mexico Normal University. It has been indicated that the University of Arkansas would probably wish to join with the Missouri Section.

"Several institutions in other parts of the country have been

considering changing their affiliations with Sections, but no definite conclusions have been reached.

"Information concerning the constitutional provisions for forming a Branch was furnished to Michigan State College but the Committee has not been informed that a Branch has been organized.

"Some of the Sections have sent copies of their programs to the Chairman of other Sections and these have proved helpful in planning programs. It is suggested that the secretaries of the sections and branches be requested to exchange copies of their programs with all of the other sections and branches.

"Early last fall the Committee informed the chairmen of sections of the action taken by the Executive Committee at the Pennsylvania State College meeting to discontinue the 50 cents per member rebate (when dues were paid before a given time). Protests were received from several sections. The Texas Section, meeting at El Paso, March 22–23, went on record as favoring reducing the dues to $4.50. T. H. Morgan, Chairman of the New England Section, suggests that an allotment of 15 cents per member in the area of the section would be of great benefit.

"The meetings of the sections and branches are a very important part of the activities of the Society. It is the only direct contact many of our members have with the Society because they are unable to make long journeys to the annual meetings. The programs which have been sent to the Committee have indicated papers, round tables and discussions covering a wide range of subjects of interest to engineering teachers. The most notable program was that of the Pacific Southwest Section which held its 8th Annual Convention at the University of Nevada, Reno, December 28–30, 1939."

The following individual members were elected:

Ager, Raymond W., Assistant Professor of Electrical Engineering, University of California, Berkeley, Calif.

Bjerg, Hartwig O., Instructor in Engineering, Arizona State Teachers College, Flagstaff, Ariz.

Brater, Ernest F., Instructor in Civil Engineering, University of Michigan, Ann Arbor, Mich.

Crouch, W. George, Assistant Professor of English, University of Pittsburgh, Pittsburgh, Pa.

French, Orval C., Instructor in Agricultural Engineering, University of California, Davis, Calif.

Gilmore, Eugene A., Assistant Professor of Economics, University of Nebraska, Lincoln, Nebr.

Graf, Samuel H., Professor of Mechanical Engineering, Director of Engineering Research, Oregon State College, Corvallis, Ore.

Green, Roy M., Consulting Engineer, Western Laboratories, 921 Q St., Lincoln, Nebr.

Herreman, Harold M., Instructor in Mechanics, Colorado School of Mines, Golden, Colo.

Jones, Paul G., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

Lay, Walter E., Professor of Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

Libby, Hugo L., Instructor in Electrical Engineering, State College of Washington, Pullman, Wash.

Maesdo, G. Morales, Mining Engineer, Engineering School, 205 Tupac Amaro, San Isidro, Lima, Peru.

Nicholson, Hugh P., Assistant Professor of Mining Engineering, University of Illinois, Urbana, Ill.

Patterson, Stanley, Instructor in Mechanical Engineering, Southern Methodist University, Dallas, Texas.

Randall, Merle, Professor of Chemistry, University of California, Berkeley, Calif.

Sadler, Walter C., Associate Professor of Civil Engineering, University of Michigan, Ann Arbor, Mich.

Scofield, Walter F., Instructor in Civil Engineering, The Rice Institute, Houston, Texas.

Shallenberger, William H., Instructor in Mechanical Engineering, University of Southern California, Los Angeles, Calif.

Shaw, G. Reed, Assistant Professor of Geodesy and Transportation, Renssalaer Polytechnic Institute, Troy, N. Y.

Stiening, Frank H., Professor and Acting Head, Dept. of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa.

The following budget for 1940–41 was adopted:

| | | | |
|---|---|---|---|
| *Receipts:* | | | |
| Current dues: individuals | | $12,755.00 | |
| institutions | | 2,250.00 | $15,005.00 |
| Back dues | | | 900.00 |
| Advertising | | | 2,000.00 |
| Sale of publications and emblems | | | 400.00 |
| | | | $18,355.00 |
| *Disbursements:* | | | |
| Meeting | | 900.00 | |
| JOURNAL and *Proceedings* | | 8,000.00 | |
| Committees and conferences | | 600.00 | |
| Honorarium of Secretary | | 2,000.00 | |
| Clerical assistance | | 4,000.00 | |
| Sundry printing | | 300.00 | |
| Postage, telephone and telegraph | | 600.00 | |
| Contingent fund for Officers | | 600.00 | |
| Travel, Secretary's Office | | 400.00 | |
| Dues: | | | |
| American Council on Education | $100 | | |
| American Engineering Council | 250 | 350.00 | |
| Contribution to E. C. P. D. for Committee on Engineering Schools | | 500.00 | 18,250.00 |
| Estimated surplus | | | $ 105.00 |

A vote of thanks was unanimously and vociferously given to B. M. Woods, a member of Council, for his splendid work in connection with the meeting. Council expressed its appreciation of the excellent work of President Ferguson.

Respectfully submitted,

F. L. BISHOP, *Secretary.*

## MINUTES OF THE 48TH ANNUAL MEETING

The 48th annual meeting of the Society for the Promotion of Engineering Education was held at the University of California, Berkeley, June 24–28, 1940. All meetings were held in Wheeler Hall. O. J. Ferguson, Dean, College of Engineering, University of Nebraska, was the President. 924 members and guests were registered. There were four general sessions of the Society and conferences of twenty different groups—Chemical Engineering, Civil Engineering, Comprehensive Examinations, Coöperative Engineering Education, Electrical Engineering, Engineering Drawing, Engineering Economy, Engineering Research, English, Evening Courses, Industrial Engineering, Instructional Methods, Junior Colleges, Labor Relations, Mathematics, Mechanical Engineering, Mechanics, Mineral Technology, Personal Development and Physics. The Council met every morning but Thursday at seven o'clock breakfast.

The first general meeting was held on Tuesday morning with President Ferguson presiding. B. M. Woods, Chairman of the Local Committee on Arrangements, welcomed the Society to the University of California; Monroe E. Deutsch, Vice-President and Provost of the University, addressed the members; O. J. Ferguson presented his presidential address, Is the Philosophy of Engineering Education Changing?; D. B. Steinman, New York City, presented An Engineer's View of Engineering Education; and Widening Opportunities of Engineering Institutions to Contribute to Public Welfare was presented by E. L. Moreland, Massachusetts Institute of Technology. The reports of the Secretary and the Treasurer were accepted.

Vice-President and Mrs. Deutsch entertained the members and guests at the Stephens Union from three to six.

The second general session was held on Wednesday morning with President Ferguson presiding. He turned the meeting over to A. R. Cullimore, Newark College of Engineering, who was the coordinating chairman of the three committees sponsoring the session—Development and Placement of Engineering Graduates; Undergraduate Adjustment and Guidance; and Student Selection and Orientation. J. R. Bangs, Cornell University, presented What Industry Considers Promising Material which was discussed by R. J. Heffner, Bell Telephone Labs. Exploring Promise in the Undergraduate, by Edward K. Strong, Stanford University, and Discovery of Promising Freshman Engineers, by I. C. Crawford,

University of Kansas, were discussed by H. S. Rogers, Polytechnic Institute of Brooklyn.

On Wednesday afternoon the Society was the guest of Stanford University. After a tour of inspection of the campus, we were entertained by an organ recital in the Stanford Memorial Church, and at four thirty there was a demonstration of the two million volt artificial lightning in the Harris J. Ryan High Voltage Laboratory.

The third general session was held on Thursday morning with Vice-President D. B. Prentice, Rose Polytechnic Institute, presiding. New Applications of Aeronautics was presented by W. F. Durand, Stanford University. President Ferguson presented the latest information he had received on the emergency training program. R. E. Davis, University of California, read his paper, Relation Between the University of California College of Engineering and the Junior Colleges of the State; General Engineering Trends by S. B. Morris, Stanford University; Report of California Emergency Committee by B. M. Woods; and a Report on the Investigation of the Teaching of English to Engineering Students by H. S. Rogers, Polytechnic Institute of Brooklyn.

The annual dinner was held in the Claremont Hotel with President Ferguson presiding. A. A. Potter, Dean, Schools of Engineering, Purdue University, was the thirteenth recipient of the Lamme award. The citation was made for the committee by H. B. Langille, University of California. In accepting the medal, Dean Potter said: "I feel most humble when I consider the master engineering teachers who have received the Lamme Medal. You of the engineering teaching profession have been most kind and generous to me.

"Teaching, like music or painting, is an idealistic profession and a teacher, like an artist, works best in an atmosphere which is pleasant and free from organization worries. If I have contributed anything to engineering education it is due largely to the pleasant environment made possible for me by my colleagues and other friends in the engineering profession.

"The master-teacher loves his work—he derives his greatest satisfaction from the accomplishments of his students and from the opportunity afforded him to work in an atmosphere which is conducive to scholarship, high ethical standards and fine family life. Those of us who are in educational administrative positions can contribute to effective teaching by protecting our colleagues from anxiety, by friendly counsel and by encouraging them in their endeavors.

"During these uncertain times it is our opportunity and our duty to impress upon our colleagues and students that mental and emotional balance is maintained only by those who think with a minimum of passion and act with a maximum of self-restraint. We

must maintain our faith in the American system which has at all times spurred the individual to greater accomplishments, and which has been able to guarantee to all of us the right of life, liberty and the pursuit of happiness."

The report of the Nominating Committee was accepted and the following officers for 1940–41, and members of the Council for three years were elected:

President: D. B. Prentice, Rose Polytechnic Institute, Terre Haute, Ind.

Vice-Presidents: L. E. Conrad, Kansas State College, Manhattan, Kansas; E. L. Moreland, Massachusetts Institute of Technology, Cambridge, Mass.

Secretary: F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Treasurer: W. O. Wiley, John Wiley & Sons, Inc., New York City.

Assistant Secretary: Nell McKenry, University of Pittsburgh, Pittsburgh, Pa.

Council (Terms expiring in 1943): W. Otto Birk, University of Colorado, Boulder, Colo.; H. A. Curtis, University of Missouri, Columbia, Mo.; A. R. Cullimore, Newark College of Engineering, Newark, N. J.; H. E. Degler, University of Texas, Austin, Texas; Carl S. Ell Northeastern University, Boston, Mass.; D. P. Savant, Georgia School of Technology, Atlanta, Ga.; Geo. T. Seabury, American Society of Civil Engineers, New York City.

President-Elect Prentice was introduced and said: "Mr. President, may I express to this group my deep appreciation for this expression of confidence and for this honor. I appreciate it more than I can put into words, especially at this moment.

"You know and I know that in the months to come engineering education faces serious problems. But I am confident that the engineering colleges and the engineering faculties will meet the problem of this emergency as effectively and as successfully as they have for years carried on the program of engineering education under normal conditions."

Two addresses were delivered at the dinner, Trends in Engineering Education by Charles Derleth, University of California, and Those Extra Subjects of Study by L. P. Sieg, University of Washington.

The fourth general session was opened by Vice-President Prentice in the absence of Vice-President Sorensen. The meeting was turned over to H. J. Gilkey, Iowa State College, as leader of the round table discussion on the report of the Committee on Aims and Scope of Engineering Curricula. Written discussions were presented by Franklin Thomas, California Institute of Technology,

H. E. Wessman, New York University, R. E. Doherty, Carnegie Institute of Technology, E. L. Moreland, Massachusetts Institute of Technology, I. C. Crawford, University of Kansas, and P. T. Norton, Virginia Polytechic Institute. It was necessary for H. P. Hammond, Pennsylvania State College, Chairman of the Committee whose report was to be discussed, to leave the meeting for other duties and R. E. Doherty substituted for him. A number participated in the discussion from the floor. The following resolution was presented by the Committee on Resolutions and unanimously adopted by the convention:

The Society for the Promotion of Engineering Education assembled at the University of California, in its Forty-Eighth annual meeting June 24 to June 28, 1940, hereby adopts the following resolutions.

We wish to express to all those at the University of California our appreciation, gratitude, and pleasure for the attention which has been given, in every detail, to our needs and desires. Surely nothing more could be asked for than has been done.

In particular, we wish to compliment Vice-President Monroe E. Deutsch for his patriotic and stirring speech of Tuesday.

To Professor Baldwin M. Woods and all his committeemen, we extend greetings and thanks.

To Mrs. Bruce Jameyson and her committee, the ladies wish to express their appreciation and delight for the many entertainments and interesting trips provided in their honor.

To President Ferguson, we offer our salute in acknowledgment of a masterful annual address, and further to him and the Council, our congratulations for the very successful conduct of this annual meeting.

To the chairmen of the various conferences, we say "Well Done," as is attested by the good attendance at all of them.

To Vice-President and Mrs. Deutsch we wish to express our appreciation for the very pleasant reception on Tuesday afternoon.

To the authorities at Leland Stanford University, we extend an expression of our gratitude for the privilege and stimulating experience of visiting that outstanding institution.

PAUL CLOKE,
C. E. MACQUIGG,
P. S. DONNELL.

There being no further business to come before the meeting, it was adjourned at 12 M.

F. L. BISHOP, *Secretary.*

## 1940 NATIONAL DRAWING COMPETITION

SPONSORED BY THE DIVISION OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY

| Class | Code No. | Student | Institution | Instructor | No. of Entries |
|---|---|---|---|---|---|
| AP | | | | | |
| First Place | 11 | F. J. Salamone | Union College | R. L. Stanley | 15 |
| Second Place | 311 | J. T. Tardi | Rensselaer | G. B. Achtmeyer | |
| Third Place | 441 | J. G. Harter | N. Mexico State | J. H. Butler | |
| AI | | | | | |
| First Place | 202 | R. Kell | U. of Nebraska | E. J. Marmo | 22 |
| Second Place | 352 | C. W. Birch, Jr. | U. of Maine | B. C. Kent | |
| Third Place | 222 | R. L. Rix | Texas A. & M. | R. O. Loving | |
| BP | | | | | |
| First Place | 333 | B. M. Bowman | U. of Michigan | F. H. Smith | 19 |
| Second Place | 313 | J. Cook | Rensselaer | A. G. Fisch | |
| Third Place | 213 | J. S. Dwyer | Oklahoma A. & M. | A. L. Steele | |
| BI | | | | | |
| First Place | 224 | A. R. Huse | Texas A. & M. | J. G. McGuire | 17 |
| Second Place | 264 | K. D. Peterson | U. of Detroit | J. Gerardi | |
| Third Place | 204 | W. S. Wagner | Ohio State | A. Philby | |
| CI | | | | | |
| First Place | 315 | F. Parkinson | Rensselaer | J. S. Rising | 22 |
| Second Place | 225 | F. T. Phillips | Texas A. & M. | J. G. McGuire | |
| Third Place | 165 | F. A. Gorges | San Mateo J. C. | F. Paulsen | |
| CS | | | | | |
| First Place | 316 | R. C. Whitney | Rensselaer | A. G. Fisch | 17 |
| Second Place | 206 | R. Cannell | U. of Nebraska | E. J. Marmo | |
| Third Place | 266 | G. M. Galster | U. of Detroit | J. Gerardi | |
| D | | | | | |
| First Place | 67 | J. M. Bowyer, Jr. | Kansas State | G. F. Branigan | 14 |
| Second Place | 227 | J. H. Scholl | Texas A. & M. | T. H. Terrell | |
| Third Place | 317 | D. McFarland | Rensselaer | J. S. Rising | |
| E | | | | | |
| First Place | 228 | W. M. Adkisson | Texas A. & M. | H. C. Spencer | 14 |
| Second Place | 268 | J. A. Green | U. of Detroit | J. Gerardi | |
| Third Place | 78 | P. Lynch | Texas Tech. | Mrs. Atkinson | |
| F | | | | | |
| First Place | 269 | J. J. Sazynski | U. of Detroit | J. Gerardi | 15 |
| Second Place | 169 | J. M. Schmitz | San Mateo J. C. | F. Paulsen | |
| Third Place | 209 | A. Andrew | U. of Nebraska | E. J. Marmo | |

*Judging Committee*

B. M. GREEN, Stanford University,
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J. H. BUTLER, N. Mex. State College,
O. W. POTTER, Univ. of Minnesota,
F. O. ROSE, U. of S. California,
E: C. SCHOTT, Santa Clara Univ.

*Editor's Note.*—Only 155 drawings from 29 institutions were submitted this year compared with 198 entries from 33 schools last

year. This is quite a reduction and it is impossible to say, at this date, whether it indicates a lack of interest in the competition or is due to other causes.

The judges did not submit any formal comments this year. Several expressed themselves informally to the effect that most of the so-called "freehand" sketches in Class CS did not fulfill the spirit of the specifications in that the sketches had very evidently been laid out with some sort of measuring instrument and were not, therefore, truly freehand.

The Editor will be glad to receive comments on the contest just closed and any suggestions for problems for next year, all of which will be forwarded to the new Competition Chairman.

## DEVELOPMENT AND ACTIVITIES OF THE CIVIL ENGINEERING DIVISION

The Civil Engineering Division of the Society is entering its seventh year of existence. Organized by an enthusiastic group of civil engineering teachers at the Society meeting at Cornell University in June, 1934, the Division has grown and developed progressively, although conservatively, to fill a need which was probably only partly recognized at the start. Each year has brought changes and innovations in the activities of the Division, but the sustained interest of the members has resulted in sufficient continuity of effort to build upon past experiences.

There are now eight regular committees in the Division of nine members each. In turn these principal committees have set up sub-committees made up from outside of their own membership for the purpose of carrying on special investigations and studies. Probably as many as two hundred or more members actively contribute constructively to the Division's program. The following regular committees are included: I. Educational Policy and Teaching Methods; II. Structural Engineering; III. Sanitary Engineering; IV. Transportation; V. Applied Hydraulics; VI. Construction Education; VII. Foundations and Soil Mechanics; VIII. Surveying and Geodesy.

The spontaneity and wholeheartedness of the activity of these groups, which has been evident at the annual meetings of the Society, stands as a tribute to those with the vision to set up and foster the Division in its early existence.

The work of the committees has become so prolific in some instances that they have individually, and in some instances in cooperation with organizations not in the realm of S. P. E. E., fostered specialized conferences outside of the regular meetings of the Society. Thus since the start of 1939 the Division through its committees has sponsored the following:

Third Regional Conference on Surveying and Mapping, sponsored by Committee VIII at Missouri School of Mines, April 6–8, 1939.

Conference on Hydraulics and Sanitary Engineering, sponsored by Committee V at University of Iowa, June 12–15, 1939.

Fourth Regional Conference on Surveying and Mapping, sponsored by Committee VIII at Georgia School of Technology, September 6–8, 1939.

Second National Surveying Teachers Conference, sponsored by Committee VIII at Camp Case (Case School of Applied Science), Loudonville, Ohio, July 30–August 8, 1940.

Conference on Soil Mechanics and Foundations, sponsored by Committee VII at Purdue University, September 2–7, 1940.

The first of these specialized national meetings was initiated as an innovation of the Division by the Committee on Surveying in the summer of 1937 at the University of Iowa's Camp Marston, Rainy Lake, Minnesota. Others have been held in structural engineering and surveying and mapping:

First Regional Conference on Surveying and Mapping, sponsored by Committee VIII at Rensselaer Polytechnic Institute, March 24–26, 1938.

Conference on Structural Practice, sponsored by Committee II at Armour Institute of Technology, June 20–23, 1938.

Second Regional Conference on Surveying and Mapping, sponsored by Committee VIII at the University of Louisville, September 5–8, 1938.

In the offing is one in hydrology to be held at Pennsylvania State College by coöperation with the Section of Hydrology of the American Geophysical Union with the Civil Engineering Division of S. P. E. E. Publications covering these various conferences have been issued by coöperative effort in some instances. The Division also publishes three times a year the *Civil Engineering Bulletin* which in December will appear as the first number of Volume 6.

Another valuable contribution of the Division is the preliminary report on "Civil Engineering Library List" prepared by the Special Committee on Library Facilities, published by courtesy of the Macmillan Company in June, 1938. There is here presented a carefully classified list of treatises, handbooks and other publications considered valuable in a civil engineering library.

There is thus presented in the foregoing a very brief resume of the present and immediate past activities sponsored by the Division. Many of the varied activities have aroused interest of those outside of the teaching profession. This is particularly true of the specialized fields fostered by the committees. It is to be hoped that many more programs will be forthcoming which, in addition to teachers of engineering, will enlist the interest of engineers more remotely associated with educational institutions with a view of stimulating professional activity in a way which will provide a mutually sympathetic understanding of fundamental engineering and engineering education problems within and outside of engineering colleges.

Persons interested in the activities of the Division and its committees are urged to communicate with the chairman or any member of the administrative committee, indicating their particular interest in the Division's affairs.

## OFFICERS OF DIVISIONS FOR 1940–41

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# ENGINEERING ECONOMY NOTES

*Engineering economy is that phase of engineering work in which technical plans and operations meet the critical and constructive tests of applied economics.*

EDMUND D. AYRES, The University of Wisconsin, *Editor*

## CLASSIFICATION OF ENGINEERING ECONOMY PROBLEMS

The remarks on engineering economy in the May issue lead me to make a suggestion.

It would clarify the matter if those working in engineering economy would classify problems into certain general groups. The solution of some of these groups would be a matter of general agreement. Thus we could pin down to certain groups the cause of disagreement. For example, two groups it seems to me are:

(*a*) it is decided to purchase equipment; how much shall be bought? (steam pipe insulation a simple case, boiler units in a steam power plant a more complicated case),

(*b*) relative economy of two proposed methods such as turret lathe versus an automatic lathe on machine parts.

J. R. CONNELLY, *Lehigh University*

Practically all of the problems involving economic analysis which confront the engineer are of the investment choice type, requiring the selection of one alternative from two or more as the most desirable course for the investment of money. A classification which has some merit first divides these problems into (1) those embracing few alternatives in contrast to (2) those embracing many. Second, it classifies these problems in general into those (1) in which revenues or incomes may be compared with expenses or outgo in contrast to (2) those which require a choice of alternative when revenues or incomes are neither available nor reasonably possible of allocation for the purpose of comparison with expenses involved.

Such classifications as those above fail to include many types of problems and in addition fail to put sufficient emphasis upon many important considerations. They are, however, helpful and Professor Connelly has pointed out one of the first steps that seem necessary for the isolation of areas of disagreement. It is hoped that some of our readers will send in classifications of these problems which they have used with satisfaction in their own work. Meanwhile perhaps this page might well be utilized to begin explorations in the hope of isolating one disagreement after another.

## SECTIONS AND BRANCHES

The **Allegheny Section** will hold its sixth annual meeting at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, on Friday and Saturday, October 25 and 26, 1940. The theme of this meeting will be "The Coördination of Engineering Curricula." Committee on Arrangements: Emerson M. Pugh, Chairman, Frederic C. Stewart, Vice-Chairman, Joseph B. Rosenbach, Secretary-Treasurer.

The Engineers' Council for Professional Development is meeting in Pittsburgh on Thursday, October 24, 1940, and its members are cordially invited to attend the Allegheny Section meeting.

PROGRAM

*Friday Afternoon, October 25*

1:00 P.M. Registration—The Foyer, College of Fine Arts.

2:00 P.M. Business Session—The Theatre, College of Fine Arts. Emerson M. Pugh, Chairman, presiding.

Address of Welcome. Robert E. Doherty, President, Carnegie Institute of Technology.

Response. Frederic C. Stewart, Pennsylvania State College, Vice-Chairman.

Report of the Nominating Committee and Election of Officers.

New Business.

2:20 P.M. First Technical Session—The Theatre, College of Fine Arts. John P. H. Perry, Chairman of the Executive Committee, Engineers' Council for Professional Development, presiding.

"Fundamentals of Professional Education." Elliott D. Smith, Master of Saybrook College, Yale University.

"The Scientific-Technological Stem of Engineering Education." William E. Wickenden, President, Case School of Applied Science.

"The Social-Humanistic Stem of Engineering Education." Willard E. Hotchkiss, Maurice Falk Professor of Social Relations, Carnegie Institute of Technology.

Discussion.

2:30 P.M. Conducted tour for attending ladies—Survey of American Painting, The Galleries, Carnegie Institute.

4:30 P.M. Tea—The Exhibition Room, College of Fine Arts.

*Friday Evening, October 25*

6:30 P.M. Banquet—Boggs and Buhl Dining Room. Robert E. Doherty, Toastmaster.

Address: "People Still Reach for the Stars." Charles F. Lewis, Director, The Buhl Foundation.

9:00 P.M. Conducted tour of the new Buhl Planetarium and a special performance in the Theatre of the Stars.

*Saturday Morning, October 26*

9:00 A.M. Registration—The Foyer, College of Fine Arts.

10:00 A.M. Second Technical Session—The Theatre, College of Fine Arts. Donald B. Prentice, President, Society for the Promotion of Engineering Education, presiding.

"Coördination of Industry with Engineering Colleges." Walther Mathesius, Vice President, United States Steel Corporation.

"Coördination of Liberal Arts and Engineering Education—3–2 Plan." William P. Tolley, President, Allegheny College.

"Coöperative Engineering Education." Douglas F. Miner, George Westinghouse Professor of Engineering, Carnegie Institute of Technology.

Discussion.

*Saturday Afternoon, October 26*

2:00 P.M. Football Game—Case vs. Carnegie Tech—The Stadium.

5:00 P.M. Social Hour—The University Club.

*Saturday Evening, October 26*

8:15 P.M. A special performance by the Drama Department, Carnegie Institute of Technology—The Theatre, College of Fine Arts.

The sixth annual meeting of the **Illinois-Indiana** Section was held at the University of Notre Dame on April 20, 1940. An informal dinner, at which a quartet from the University Glee Club

and several members of the varsity fencing team entertained, was held at the Hotel La Salle Friday evening preceding the meeting. Approximately 200 persons from the various Illinois and Indiana universities and colleges attended the Saturday sessions.

The morning session was opened with an address of welcome by Rev. J. Hugh O'Donnell, C.S.C., President of the University of Notre Dame. The session consisted of three addresses and was concluded with a short business session at which the new officers were elected. The first address of the morning session was given by Rev. John J. Cavanaugh, C.S.C., Vice-President of the University, who spoke on "Intellectual and Moral Education at Notre Dame." In this address he integrated the religious and intellectual elements in a college training.

In the second talk Dugald C. Jackson, Jr., Dean of the College of Engineering at Notre Dame, pointed out the need for a broader and more fundamental curriculum in engineering through increased emphasis on basic science and humanistic and social studies. In the final address, F. G. Seulberger, Director of the Department of Industrial Relations of Northwestern Technological Institute, outlined the program that was being initiated at that school.

At the afternoon session addresses were given by W. S. James, Chief Engineer of the Studebaker Corporation, and T. A. Boyd, Head of the Fuel Dept. of General Motors Research Laboratories. Mr. James suggested that the university should strive to give the student a more practical concept of the various kinds of engineering. He advocated that the two fundamentals, physics and chemistry, should be taught throughout the entire undergraduate course in terms of their application to all branches of engineering. It was his opinion that the university was not expected to produce a finished engineer.

Mr. Boyd was the principal speaker of the one-day session. In his address entitled, "You and Research," he stressed the importance of pursuing the research method of approach regardless of the type of engineering studied. He told the audience that an intimate knowledge of individual subjects is necessary but that the details of any one type of engineering need not be mastered. This address was enthusiastically received and numerous members requested that steps be taken to have it published in THE JOURNAL OF ENGINEERING EDUCATION.

After the morning session luncheon was served in the University Dining Hall. The members and guests had the opportunity of inspecting the engineering and science laboratory facilities as well as visiting other places of interest at the University. Doughnuts and coffee were served in the Engineering Building at the conclusion of the afternoon session.

The following officers and committee members for 1941 were unanimously elected at the business session:

*Chairman:* W. A. Knapp, Purdue University.
*Vice-Chairman:* G. A. Maney, Northwestern University.
*Secretary-Treasurer:* M. W. Todd, Purdue University.
*Executive Committee:* V. G. Potter, Armour Institute; L. F. Stauder, University of Notre Dame; P. G. Andres, Lewis Institute; H. A. Moench, Rose Polytechnic Institute; F. L. Ehasz, University of Illinois; W. L. Shilts, University of Notre Dame, retiring chairman.

The seventh annual meeting will be held next spring at Lafayette, Indiana, with Purdue University acting as host.

ERNEST J. WILHELM,
*Secretary-Treasurer.*

During the year 1939–40 under the able leadership of Professor H. B. Roe, the **Minnesota Section** held three regular dinner meetings, one in each quarter, and two special meetings. The latter were held in the fall quarter for the purpose of considering the Preliminary Report of the Special Committee (S.P.E.E.) on Aims and Scope of Engineering Curricula (dated November 16, 1939). The consensus of the Section was favorable to the report and the national secretary was so notified.

The fall quarter meeting was held November 24, 1939, at which time W. C. MacFarlane, President of Minneapolis Moline Implement Company, gave a very informal talk on "What Industry Expects from Engineering Education." He emphasized the need of more leadership on the part of the graduating engineering student and for greater ability to adapt his theoretical training to standard and efficient practices essential to industry. There were 34 members and guests present.

The winter quarter meeting, February 29, 1940, was held in conjunction with "open house" in the new Oak Street Laboratories. Frank B. Rowley, Director of the Engineering Experiment Station, was kind enough to offer his services in describing the layout of the laboratories, the equipment available, and the research projects being carried on in addition to the regular undergraduate laboratory work. Other members of the staff more closely associated with certain research projects were called upon for more detailed information. Those responding were: B. J. Robertson, Airplane Engine Testing; Charles Boehnlein, Wind Tunnels; Paul Andersen, Lateral Earth Pressures and Concrete Studies; Mr. Lund, Moisture Condensation Within Walls; Profes-

sor Reyerson, Treatment of Manganese Ores; and Professor Wise, Steel Beam Networks. The 46 members attending were then free to make a tour of inspection and to become better acquainted with the work being done in this particular part of the Engineering Experiment Station at Minnesota.

At the spring quarter meeting held May 13, 1940, officers for the ensuing year were elected as follows: C. A. Herrick, section chairman; E. W. Johnson, chairman of the program committee; T. P. Hughes, secretary. As speaker of the evening Henry Schmitz, Chief of the Division of Forestry, gave a very interesting talk on Forest Conservation. A most lively and lengthy discussion followed. Members and guests present were 34.

F. E. MILLER, *Secretary.*

# G-E Campus News

## ATOMIC ENERGY

TWO scientists at the General Electric Research Laboratory, Schenectady, have recently isolated a tiny quantity of U-235—a rare form of uranium—which, they believe, is a step toward releasing the vast storehouse of atomic energy. From this U-235 may some time be obtained several million times as much energy as from an equal amount of coal.

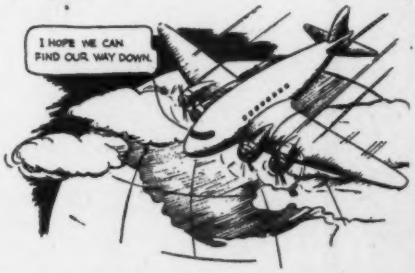
When an atom of U-235 is attacked by a "slow" neutron, it explodes into two other elements and several "fast" neutrons, unleashing 200,000,000 electron volts of atomic energy. If the "fast" neutrons can be slowed down, and enough atoms of U-235 provided, a chain reaction may be developed—a battle royal between slow neutrons and uranium atoms—providing large amounts of useful energy.

It is generally thought that at least a pound of U-235 would be required to make possible the energy-releasing chain reaction. This seems quite out of the question at present since the maximum rate of production with existing methods is about one ten-billionth of a pound per hour.

The G-E men responsible for the isolation of U-235 are Dr. K. H. Kingdon and Dr. H. C. Pollock. Dr. Kingdon is a graduate of the University of Toronto, and Dr. Pollock, only 26 years old, was graduated from the University of Virginia.

## FLYING HIGH

AT altitudes of 20,000 feet the air gets pretty thin and cold. In an open-cockpit plane you'd have to wear an oxygen mask and a fur-lined suit, or it would be just too bad.




However, passengers in planes such as Pan-American Airway's new Strato-Clipper *Flying Cloud* don't have to worry about flying at great heights. Clad in ordinary street clothes, they simply climb into the ship, sit back in their easy chairs, and have lunch while they speed along in ease and comfort. New G-E superchargers make this high-flying comfort possible by maintaining proper air pressures in the cabin, while another set of G-E superchargers compresses the air for the engines.

Superchargers are made in General Electric's Lynn (Mass.) Works, where they, as well as huge motors, ship-propulsion equipment, and turbines, are tested by student engineers taking the G-E Test Course.

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